CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

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ENVIRONMENTAL CONSEQUENCES

4.7 Effects of the Cumulative Case

The National Environmental Policy Act and its implementing guidelines require an assessment of the proposed project and other projects that have occurred in the past, are occurring in the present, or are likely to occur in the future, which together may have cumulative impacts that go beyond the impacts of the proposed project itself. According to the Act (40 CFR §1508.7 and 1508.25[a][2]):

> "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In addition, to determine the scope of environmental impact statements, agencies shall consider cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

The purpose of this cumulative effects analysis is to determine if the effects of non-oil and gas activities, and oil and gas activities, on the North Slope, including proposed actions in the Planning Area, have the potential to interact or accumulate over time and space, either through repetition or combined with other effects, and under what circumstances and to what degree they might accumulate (NRC 2003).

4.7.1 Structure of the Cumulative Impacts Analysis

For this amendment, the analysis of cumulative impacts is a four-step process that follows guidance provided in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997) and *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC 2003):

1. Specify the class of actions whose affects are to be analyzed;
2. Designate the appropriate time and space domain in which the relevant actions occur;
3. Identify and characterize the set of receptors to be assessed; and
4. Determine the magnitude of effects on the receptors and whether those effects are accumulating.

4.7.1.1 Class of Actions Whose Affects are to be Analyzed

Both non-oil and gas activities and oil and gas activities, advances in technology, and climate change are considered in the analysis. The assumptions and scenarios used by the resource specialists in the analyses of the cumulative impacts include those identified for the Planning Area in Section 4.2 (Introduction and Basic Assumptions for the Environmental Consequences Assessment).

Non-Oil and Gas Activities

Non-oil and gas activities include those activities that have occurred in the past, are presently occurring, or are likely to occur in the future. These include activities discussed in Section 4.2.1.1, Activities Not Associated with Oil and Gas Exploration and Development, that could occur within and outside of the Planning Area, and other

North Slope activities, including resettlement and expansion of Native villages, and other residential, commercial, and industrial development on the North Slope, and military (DEW-Line) and other government sites.

Oil and Gas Activities

Oil and gas activities include those direct and indirect activities that have occurred in the past, are presently occurring, or are likely to occur in the future. These include activities discussed in Section 4.2.1.2, Oil and Gas Exploration and Development, that could occur within the Planning Area and on the North Slope. The activities likely to have the greatest effects vary by resource. For example, oil and gas activities considered in greatest detail in the cumulative impacts analysis for biological resources are:

- Exploration activities, including seismic activities, off-road travel, and exploration drilling
- Road construction (ice, peat, and gravel roads)
- Industrial activity (oil field development and production and related infrastructure)
- Oil spills
- Marine-related activities
- Site reclamation

In contrast, employment and income are important activities to consider when evaluating the economy. Activities analyzed for each resource are identified in Section 4.7.7, Analysis of Cumulative Effects By Resources.

Advances in Technology

Over the past 2 decades, new technologies have been developed and applied to exploration, development, and production on the North Slope. Some technologies, such as the use of ice roads and ice pads for exploration wells and the Arctic Drilling Platform, are unique to the Arctic and were largely developed in Alaska. Other advances, such as the use of coiled tubing, 3-D seismic-data acquisition, horizontal and multilateral drilling, measurement while drilling, low ground-pressure vehicles (Rolligons), and remote sensing were developed elsewhere. These technologies have been important in reducing cumulative effects to resources from oil and gas activities and are discussed in more detail in Section 4.7.4, Advances in Technology.

Global Climate Change

This amendment also considers the effects of global climate change in assessing cumulative effects. The effects of past, current, and future activities on the North Slope could be much greater on the permafrost landscape than would be the case if the climate were relatively stable. While impacts of global climate change are likely to be most evident in the Arctic, the causes of global climate change and the contribution of emissions from fossil fuels to those causes are global in scope. Consequently, North Slope oil and gas activities need to be viewed in that context. Although activities associated with exploration, development, and production of oil and gas resources on the North Slope, and the burning of petroleum resources discovered on the North Slope¸ will produce some greenhouse gases, their contribution to global climate change is negligible as the North Slope provides only a small fraction of all fossil hydrocarbons burned on earth (NRC 2003).

4.7.1.2 Appropriate Temporal and Spatial Domain

Temporal Domain

The analysis period covered by the cumulative effects analysis begins in 1900, when first exploration on the North Slope began, and continues through 2100. The ending date is based on the assumption that oil and gas fields will be discovered and developed in the Planning Area during the next 20 years, that exploration and development activities that could occur more than 20 years from now, and that production and abandonment activities could last for 50 years after initial discoveries are made. Due to the difficulty of predicting advances in technology and the need for oil and gas very far into the future, however, a more reasonable analysis period, and one on which most of the cumulative effects analysis is focused, is 50 years into the future. For discussion purposes, this period has been further broken down into four analysis periods.

1. Past exploration, development, and production (activities and infrastructure associated with existing operations on the North Slope);

2. Present exploration, development, and production (activities and infrastructure associated with existing operations on the North Slope that may be currently underway or planned by 2008);

3. Reasonably foreseeable future development (oil and gas discoveries or other projects that are clearly identified and are expected to initiate development-related activities [site surveys, permitting, appraisal drilling, or construction]) within the next 20 years; and

4. Speculative development (discoveries that could be made and possibly developed beyond a 20-year timeframe, and discoveries with low commercial potential).

Spatial Domain

For individual resources and uses, the area of which an effect could be felt could be the "footprint," but for others the effect may extend well beyond that space. For example, noise effects to wildlife can extend miles beyond the footprint of the development. For purposes of this analysis and based on guidance in NRC (2003), the spatial domain for past, present, and reasonably foreseeable activities is primarily the North Slope of Alaska and its adjacent marine waters. However, this amendment also considers effects to resources that could occur outside of Alaska and its adjacent marine waters, primarily to migratory birds and mammals.

The main area of development on the North Slope is centered on the Prudhoe Bay – Kuparuk complex. The outliers of development are represented by the Alpine oil field just to the east of the Planning Area, the Northstar field offshore in the Beaufort Sea, and the Badami field (now shut-in) to the east of Prudhoe Bay. This development area encompasses an area approximately 120 to 130 miles east to west and ranging from 10 to 20 miles inland from the Beaufort Sea coastline and 5 miles offshore. The Alpine Satellite Development would extend the area of oil production to the west approximately 20 miles and in from the coastline up to 40 miles. To form a context for the proportional size of the development area, the North Slope (including the general area north of the Brooks Range) is a regional area of approximately 55,000 square miles (including the Arctic National Wildlife Refuge), with 650 miles of coastline. The oil development area (not including the TAPS corridor) is an area of approximately 3,000 square miles, with a coastline of approximately 230 miles. Thus, existing and planned oil development spans approximately 5 percent of the land area and 35 percent of the coastline of the North Slope. It should be noted that a description of the proportional area of development does not ascribe a specific level of cumulative impact to resources.

4.7.1.3 Set of Receptors to be Assessed

The set of receptors assessed in the cumulative effects analysis are the physical, biological, and human systems discussed in Chapter 3 (Affected Environment). The analysis of cumulative effects is most readily accomplished if good baseline data are available. Lack of good data or missing information makes assessing cumulative effects more difficult.

4.7.1.4 Magnitude of Effects and Whether Those Effects are Accumulating

The potential extent of the total cumulative effects (e.g., number of animals and habitat affected, jobs and revenues created or lost), and how long the effects might last (e.g., population recovery time, duration of income flows) are estimated to determine the magnitude of effects that could accumulate for each resource. Where possible, the assessment of effects on a resource is based on quantitative analysis (e.g., number of miles of gravel roads constructed; number of animals killed). However, many effects are difficult to quantify (e.g., animal behaviors; human perceptions) and a qualitative assessment of effects is made.

As suggested by the CEQ (1997) handbook, *Considering Cumulative Effects Under the National Environmental Policy Act*, this amendment considers the following basic types of effects that might occur:

- "Additive" (total loss of sensitive resources from more than one incident),
- "Countervailing" (negative effects are compensated for by beneficial effects), and
- "Synergistic" (total effect is greater than the sum of the effects taken independently).

The purpose of the analysis of cumulative effects in this amendment is to determine whether the effects are additive or synergistic or have some other relationship. Additive (or combined) effects on specific resources often are difficult to detect and do not necessarily add up in the strict sense of one plus one equals two. It is much more likely that an additive or combined effect would be greater than one but less than two. A synergistic effect, in theory, is a total effect that is greater than the sum of the additive effects on a resource. To arrive at a synergistic effect in this example (continuing with the numeric analogy), the total cumulative effect would need to end up greater than two. In the highly variable Arctic environment, where natural variations in population levels can exceed the impacts of human activity, such an effect would need to be much greater than the hypothetical two to be either measurable or noteworthy. A countervailing effect occurs when an impact has both negative and beneficial effects. For example, the removal of gravel from mines destroys vegetation and wildlife habitat (negative effect), but often leads to the creation of deep-water pools that are important to overwintering fish (positive effect).

In the analyses that follows, effects should be considered to be additive in nature, unless otherwise noted. While synergistic impacts have been demonstrated in the laboratory (for certain types of chemical reactions, for example), there is almost no evidence of such impacts occurring when dealing with biological resources in the Arctic environment. Where synergistic impacts are not specifically accounted for in the analysis section, it is because there are neither studies nor information supporting the identification of such impacts. Resource analysts have striven to keep the cumulative analysis useful, manageable, and concentrated on meaningful potential effects. The cumulative analysis considers in greatest detail activities that are more certain to happen and that are geographically in or near the Planning Area, and activities identified during scoping as being of greatest concern. Where possible, guiding principles from existing standards, criteria, and policies that control management of the natural resources of concern have been used to help focus the analysis. Where existing standards, criteria, and policies are not available, the resource experts used their best judgment on where and how to focus the analysis.

4.7.2 Activities Not Associated with Oil and Gas Exploration and Development Considered in the Cumulative Effects Analysis

In addition to oil and gas development, other reasonably foreseeable future actions were identified that would occur on the North Slope. These activities include continued human activities such as sport and subsistence hunting and fishing, commercial fishing, tourism, recreational activities. These are discussed in Section 4.2.1.1 (Activities Not Associated with Oil and Gas Exploration and Development). Other non-oil and gas activities that could occur on the North Slope include construction of a road between the Planning Area and Dalton Highway and/or Kuparuk River Unit, and growth and development associated with villages and military sites on the North Slope. The cumulative effects associated with a proposed road to the Planning Area are discussed in Section 4.12 (Possible Permanent Roads). The history of non-oil and gas development is discussed below, and the effects from past and future non-oil and gas development discussed in Section 4.7.7 (Analysis of Cumulative Effects by Resources).

4.7.2.1 North Slope Development

North Slope Development

There are presently seven North Slope villages being considered for this analysis: Point Lay, Wainwright, Atqasuk, Barrow, Nuiqsut, Anaktuvuk Pass, and Kaktovik. While a number of these locations were occupied at various times throughout the human history on the North Slope, much of the occupation prior to 1900 consisted of seasonal dwellings. These villages have been established or reestablished since 1900, and the establishment and subsequent growth represent cumulative impact to the North Slope environment. Villages consist of dwellings and other buildings, sewage and water systems, gravel roads, gravel airstrips/airports, and other structures. Their establishment, current area, and population growth are described below (Table 4-28 and Table 4-29).

The village of Point Lay has not been incorporated under State law as a municipality, but has been incorporated as a Native Village under the Indian Reorganization Act by the Bureau of Indian Affairs. In 2003, the village had a population of 260 residents and approximately 86 percent were Iñupiat Eskimos. The village has gravel roads and an airstrip, cultural center, school, health clinic, police and fire stations, and local store. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Wainwright was established in 1904 when an Alaska Native Service built a school there. The community was incorporated as a second-class city in 1962. Wainwright is currently the third largest village in the NSB with a population in 2003 of 556. The village has gravel roads and an airstrip, cultural center, school, health clinic, police and fire stations, and local store. Transportation to the village is provided by scheduled airline and charter service at the local airport.

The village of Atqasuk is at a site that has historically been the location of dwellings. Coal was mined in the community, then known as Meade River, in World War II and freighted to Barrow. The population dwindled in the 1960s but the village was re-established in the 1970s under the name Atqasuk, and incorporated as a second class city in 1982. Atqasuk had a population of 250 residents in 2003, 91 percent of whom were Iñupiat Eskimos. The village has a public electricity system, a school, police and fire stations, airstrip, health clinic, and local store. About 85 percent of households have water piped to their house. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Nuiqsut was established in 1974 when 27 families moved to the present location. The new residents lived in a tent city for 18 months before permanent housing could be built. The village was incorporated as a second-class city in 1975. In 2003, there were 416 residents in the village; about 92 percent were Iñupiat. The village has a school, health clinic, store, police and fire station, and public transportation system. All but one of the Nuiqsut households had running water in 2003. The village has a public utility (electricity) system. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Barrow is the economic, transportation, and administrative center for the NSB and the largest community, with a population in 2003 of 4,429. The city was incorporated as a first class city in 1959. Most Barrow homes are heated by natural gas from nearby gas fields. Utilities are available through Barrow Utilities and Electric Cooperative. The community has schools including a community college, stores, hotels, police and fire stations, and a bank. Transportation to and from Barrow is provided by the Wiley Post – Will Rogers Regional Airport, including jet service.

The village of Anaktuvuk Pass was settled in the 1940s. The inland Nunamiut Eskimos were nomadic and largely vacated the Brooks Range area in the early 1900s due to a collapse in the caribou populations. By the 1940s, several Nunamiut families returned to the area and settled at the present village site. The community was incorporated as a second-class city in 1957. In 2003, the population of Anaktuvuk Pass was about 329, of which approximately 88 percent were Iñupiat. The village has a school and health clinic. In 2003, approximately 90 percent of the households had running water and flush toilets. Transportation to the village is provided by scheduled airline and charter service at the local airport.

The village of Kaktovik was incorporated as a second-class city in 1971. The village has a school, police and fire stations, water and sewer systems, a local store, and health clinic. The NSB provides trash and sewage pick-up. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Military Development and DEW-Line Stations

The DEW-Line is an integrated chain of radar and communications sites stretching across Alaska, Northern Canada and Greenland. The DEW Line was initiated in 1954 when President Eisenhower signed a bill approving construction. Their purpose was to detect any incoming, over-the-pole, aircraft invasions emanating from the Soviet Union. Actual construction took place between 1955 and 1957 and the system was declared operational on July 31, 1957. A total of 58 sites were constructed; 22 of them were in Alaska, of these 14 were located along the coast of the North Slope (Table 4-30).

Table 4-28. Physical Size of the North Slope Villages Considered in the Cumulative Effects Analysis.

Village	City Limits (acres)	Tracts (acres)
Kaktovik	620	149
Anaktuvuk Pass	3,302	373
Nuiqsut	5,760	649
Atqasuk	27,353	328
Barrow	13,866	3,028
Wainwright	9,222	1,022
Point Lay	Not Incorporated	1,576
Total	60,123	7,128

Table 4-29. Population of North Slope Villages within the Cumulative Effects Analysis Area.

Village	1939	1950	1973	1980	1988	1990	1993	1998	2003
Kaktovik	13	46	144	165	227	224	230	256	284
Anaktuvuk Pass	NA	66	134	203	264	259	270	314	329
Nuiqsut	89	NA	128	208	314	354	418	420	416
Atqasuk	78	49	NA	107	219	216	237	224	250
Barrow	363	951	2,167	2,267	3,335	3,469	3,908	4,641	4,429
Wainwright	341	227	353	405	514	492	584	649	556
Point Lay	117	75	31	68	132	139	192	246	260
Total	1,001	1,414	2,957	3,423	5,005	5,153	5,839	6,750	6,524

NA – Not available.

Each DEW-Line site consisted of a gravel runway and road system, permanent housing, water and fuel storage tanks with pads, heating plants, and (petroleum/oil/lubricant [POL] and water) pipelines, garages, towers, and antennae. Military and civilian airlifts, sealifts during the summer, and cat trains distributed the materials to construct the permanent facilities. Land within the sites varied from 100 to 2,830 acres. There were three general types of stations, main stations (see Site Number column in Table 4-30), intermediate stations, and auxiliary stations. Main stations were larger and had more facilities and larger staff. Gravel runways were 5,000 feet (by 142 feet) long at main stations, 3,000 feet long at auxiliary stations, and 1,000 feet long at intermediate stations. During operation, auxiliary sites had staffs of about 25 persons each, but main stations had 225 to 250 employees. Intermediate stations were not manned.

The DEW-Line program was discontinued in 1963. Most intermediate DEW-Line sites were closed at that time but were generally not restored until the late 1990s. The remaining stations (main and auxiliary DEW-Line stations) were subsequently converted to support the newer Northern Warning System (NWS) established in 1985. Alternating stations along the coastline were converted to long range (LRR) and short range radar (SRR) sites, respectively. The LRR stations were in operation by 1990, followed by the SRR stations in 1994. The LRR and

SSR stations are still operating as of 2004. Some of these stations are stilled manned, but most were automated in the 1990s.

Abandonment, conversion, and automation left the stations with unused facilities. Clean-up and restoration of the stations occurred in the late 1990s and continues today. Many of the sites had contaminated soils or expected contamination consisting of petroleum, lubricants, PCBs, and insecticides, along with considerable volumes of debris and general refuse.

Table 4-30. DEW-Line Sites Constructed on the North Slope of Alaska.

Site Name	Site Number[1]	Size (acres)	Present Status[2]	Current Operation[3]	NWS Established[4]
Point Lay	LIZ-2 (aux)	2,835	LRR	manned	1989/1990
Icy Cape	LIZ-B (int)	218	Closed	abandoned	NA [5]
Wainwright	LIZ-3 (aux)	ND[6]	SRR	automated	1994
Peard Bay	LIZ-C (int)	1,460	Closed	abandoned	NA
Point Barrow	POW-Main	268	LRR	manned	1989/1990
Cape Simpson	POW-A (int)	ND	closed	abandoned	NA
Lonely	POW-1 (aux)	2,830	SRR	automated	1994
Kogru	POW-B (int)	150	closed	abandoned	NA
Oliktok	POW-2 (aux)	2,325	LRR	manned	1989/1990
Pt. McIntyre	POW-C (int)	ND	closed	ND	NA
Flaxman Island	POW-3 (aux)	620	SRR	automated	1994
Brownlow Point	POW-D (int)	ND	closed	abandoned	NA
Barter Island	BAR-Main	4,500	LRR	ND	1990
Demarcation Bay	BAR-A (int)	100 ac	closed	abandoned	NA

[1] Main = Main station; aux = auxiliary station; and int = intermediate station.
[2] LRR = Long Range Radar site, and SRR = Short Range Radar site.
[3] Current operations are manned, operational but automated, or abandoned – not in operation.
[4] Date Northern Warning System operations began at site.
[5] NA = Not applicable (station closed, not converted to NWS).
[6] ND = Not determined.

Site clean-up of the Icy Cape Intermediate DEW-Line site was conducted in 1997 and included removal of two 20,000-gallon and six 300-gallon oil storage tanks, 800 feet of POL pipeline, a fuel pumping station, more than forty 55-gallon POL drums, a 240-feet unmarked tower, and 1,500 cubic yards of contaminated gravel fill. Soil sampling for potential PCB-contamination was conducted on the site in 2003. Future planned restoration activities include analyzing PCB soil test samples.

A Remedial Investigation and Feasibility Study (RI/FS) was conducted and identified six Installation Remedial Program sites at the Wainwright DEW-Line Station. The RI/FS determined the source and size of each of the Installation Remedial Program sites. Building Demolition and Debris Removal (BD/DR) activities are planned for 2008-2009.

Site clean-up (restoration) of the Peard Bay Intermediate DEW-Line site was conducted in 1997 and included the removal of a fuel pumping station, a 240-feet unmarked tower, and approximately 1,000 cubic yards of contaminated gravel fill on 5 acres. Soil sampling for additional petroleum-contamination and potential PCB-contamination was conducted on the site in 2003.

The DEW-Line Station at Point Barrow has three Installation Restoration Program Sites which are scheduled for environmental restoration beginning in 2008-2009.

Site clean-up of the Cape Simpson Bay Intermediate DEW-line site was conducted in 1998, and included removal of 12 (four 20,000-gallon and eight 300-gallon) oil storage tanks, two 1,000-gallon propane tanks, a fuel pumping station, 25 batteries, buildings, a 240-feet unmarked tower, POL-contaminated soil, a contaminated gravel fill, and POL-contaminated surface water.

Based upon historical usage and prior sampling events, 10 environmental impacted sites within the former Point Lonely DEW-line station have been identified as Areas of Concern. Major chemicals of concern are POL, PCB, general refuse, and insecticides.

Site clean-up of the Kogru Intermediate DEW-line site was conducted in 1996 and included removal of eight 300-gallon oil storage tanks and more than sixty 55-gallon POL drums. Additional soil sampling was conducted in the field to verify there is not petroleum or PCB contamination.

Seven environmentally impacted areas have been identified at the Oliktok DEW-Line Station. These areas are scheduled for restoration activities under Project Clean Sweep in 2007-2008. Major environmental concerns that have been identified at these areas are POL, PCB, general refuse, and insecticides.

Five environmental areas of concern, within the former Flaxman Island DEW-Line station, have been identified with possible POL, PCB, and general refuse contamination. Project Clean Sweep has scheduled major BD/DR activities at these sites for 2008-2009.

The Barter Island DEW-line station consists of 14 determined Installation Restoration Program sites. The U.S. Air Force’s (611 Civil Engineering Squadron) Project Clean Sweep has scheduled major BD/DR activities for 2008-2009. Building/structure demolition and disposal and environmental background sampling are currently being conducted.

The Brownlow Point Intermediate DEW-Line site is currently abandoned. Most of the site has eroded into the Beaufort Sea. Site clean-up (restoration) conducted at the Brownlow Point site included the removal of one 25-feet by 80-feet unsafe building and more than 500 POL 55-gallon drums scattered over 10 acres. Due to low priority, no work is scheduled in the next 2 years. An associated 456-acre portion of the Brownlow Point site, known as Collinson Point, underwent initial site-cleanup (restoration) in 1994 and final clean-up in 2000. Removed from the site were 11 300-gallon to 550-gallon oil storage tanks, a fuel pumping station, a fuel pipeline, approximately 1,500 55-gallon POL drums, five buildings, a contaminated gravel fill, and adjacent POL-contaminated soil. Planned future environmental activities include additional site visits to determine if contamination has been cleaned up so the site can be closed.

Site clean-up (restoration) of the Demarcation Bay (Nuvagapak Point) Intermediate DEW-Line site was conducted in 1994 and again (final clean-up) in 2000, and included removal of 19 oil storage tanks, 3,000 feet of petroleum/oil/lubricant pipeline, a fuel pumping station, five buildings, and more than 7,000 55-gallon POL drums. Additional soil sampling for petroleum and potential PCB contamination was conducted in 2003.

Restoration has taken place at Manning Point. This 10-acre site served as a staging area for the Barter Island DEW-Line station from 1952 to 1957, after which there was no follow-up use of the land. Restoration included removal of more than 10,000 55-gallon POL drums, 5 tons of combustible debris, and 25 tons of noncombustible debris. Planned future environmental activities include collection and analysis of additional soil samples so the site can be closed.

Griffen Point served as a staging area for several DEW-Line stations from 1953 to 1957. The site is currently abandoned. Restoration activities have included removal of more than 1,000 55-galllon POL drums scattered along 5 miles of the Arctic Ocean frontage.

4.7.3 Oil and Gas Exploration and Development Activities Considered in the Cumulative Effects Analysis

This section discusses the history and projects the future of development in the region by identifying past, ongoing, and reasonably foreseeable oil and gas activities in the Planning Area and elsewhere on the North Slope. Oil and gas development is the main agent of industrial change on the North Slope. Oil and gas exploration and production activities have occurred on the North Slope since the early 1900s and production has occurred for more than 50 years. Associated industrial development has included the creation of an industry support community airfield at Deadhorse and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. In 1977, the TAPS began to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska. Today, it continues to transport the North Slope's entire production, and it is projected to do so for many years into the future.

For this analysis, oil and gas scenarios were developed based on estimates of future activities. The scenarios are conceptual views of the future that include the timing and extent of future petroleum activities in the Beaufort Sea and on the North Slope. Estimates of anticipated production consider many factors, including the economically recoverable resources of the area, past industry leasing and exploration efforts, and future economic conditions.

For this cumulative analysis, oil and gas activities are divided into the following categories:

- Past Exploration, Development, and Production: Exploration, development, and production activities and associated infrastructure for past, present, and future operations on the North Slope. This category involves construction and ongoing maintenance of present infrastructure, including support facilities and transportation systems.
- Present Exploration, Development, and Production: Exploration, development and production activities that may be currently under construction or approved for construction in the near future (by 2008). This category includes other non-oil-field development, including support and transportation components**.**
- Reasonably Foreseeable Future Exploration, Development, and Production: Oil and gas discoveries, or other projects, that are identified by location and are expected to initiate development-related activities (e.g., site surveys, permitting, appraisal drilling, or construction) within the next 20 years.
- Speculative Development: Potential petroleum resources and projects that could be developed beyond a 20-year timeframe. The timing and location of these discoveries and projects cannot be established, so a detailed analysis is not possible at this time.

4.7.3.1 Past Exploration, Development, and Production on the North Slope and in the Planning Area

The North Slope of Alaska is a very sparsely populated region of extreme climate, with abundant energy and other natural resources. Exploration and industrial development for extraction of the mineral resources of the region (principally oil and gas), which has been active over the past 80 years, is the primary man-induced change to the North Slope (Table 4-31).

During the 80-year oil and gas exploration period, the most intense development activity occurred during the 1970s and early 1980s. It was during this period that the Prudhoe Bay and Kuparuk oil fields were developed, TAPS and the haul road were constructed, and a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities were built. It was also a period of much activity in the National Petroleum Reserve – Alaska, with thousands of miles of seismic lines surveyed and dozens of exploratory wells drilled. Since then, additional development has occurred, but incremental physical disturbance to the environment has been reduced.

Table 4-31. Oil Exploration and Development on the North Slope.

Date	Event
Before Recorded History	Visible oil seepages used by Native inhabitants of the North Slope.
1882	U.S. government representatives hear of oil seepages while traveling in the area.
1886	First non-Natives see seepages at Cape Simpson.
1901	Peters and Schrader traverse the Brooks Range and North Slope recording the geology and geography of the region.
1906-1914	E. Leffingwell mapped the Arctic Coast east of Barrow and much of the area that now comprises the Arctic National Wildlife Refuge.
1909	First description of Cape Simpson deposits published.
1914	First oil-related claim staked.
1921	Additional claims staked by individuals and industry.
1921	Large deposits of oil discovered in Oklahoma and Texas and industry loses interest in the remote Arctic.
1922	First industry-sponsored geological investigation of North Slope oil potential.
1923	Naval Petroleum Reserve No. 4 (PET-4) established.
1923-1926	First analysis of PET-4 potential.
1943	Territory of Alaska Bureau of Mines sends field party to the North Slope to investigate oil and gas seepages.
1944	Start of PET-4 petroleum exploration program; PET-4 headquarters established at Barrow; land north of the drainage divide of the Brooks Range withdrawn from pubic entry by the Secretary of the Interior; and Public Land Order 82.
1945	Thirty-one shallow core tests drilled at Cape Simpson and oil was produced.
1945-1952	Numerous geophysical studies conducted across PET-4 find oil and gas.
1947	Office of Naval Research establishes Arctic Research Laboratory.
1949	High sulfur, heavy oil found at a test well drilled near Fish Creek, and gas discovered near Barrow.
1953-1968	Federal geologic field studies continue in PET-4 and several major oil companies begin exploration.
1957	Oil discovered in Cook Inlet (south-central Alaska).
1958	Public Land Order 82 modified; federal leasing begins on the North Slope; first industry-sponsored geological field programs; and Alaska Statehood Act passed.
1959	Alaska becomes the 49^{th} state in the Union.
1962	First industry-sponsored seismic program.
1963-1967	First industry exploration well drilled on the North Slope; 11 unsuccessful wells drilled; and industry interest in the North Slope wanes.
1964	First State of Alaska lease sale on the North Slope.
1965	Area that eventually includes Prudhoe Bay leased.
1967	Initial exploratory drilling at sites that would become Prudhoe Bay field.
1968	ARCO announces the discovery of Prudhoe Bay oil field, the largest in North America.
1969	Kuparuk, West Sak, and Milne Point fields discovered; Alaska State Lease Sale No. 23 held; and federal lease sales suspended on the North Slope for the next 10 years because the Secretary of the Interior imposed freezes due to Native claims.
1970	National Environmental Policy Act signed into law.
1971	Alaska Native Claims Settlement Act passed.
1974-1976	Federally-sponsored exploration along the Barrow Arch.
1976	PET-4 transferred from the Navy to the Department of the Interior and renamed the National Petroleum Reserve – Alaska; sale of crude oil from Petroleum Reserves 1, 2, and 3 authorized; and major exploration effort launched by the USGS in the National Petroleum Reserve – Alaska.
1977	Trans-Alaska Pipeline System operational.
1979	Initial leasing of portions of the state and federal OCS waters of the Beaufort Sea.

Table 4-31. Oil Exploration and Development on the North Slope (Cont.).

Date	Event
1980	Alaska National Interests Land Conservation Act passed.
1981	First OCS exploration well drilled.
1982	Initial leasing of portions of the National Petroleum Reserve – Alaska.
1984-1985	Seismic exploration of the Arctic National Wildlife Refuge 1002 Area conducted.
1985	First industry exploration well drilled in the National Petroleum Reserve – Alaska.
1986	Arctic Slope Regional Corporation well drilled within the coastal plain of the Arctic National Wildlife Refuge.
Various times	Initial leasing of portions of Arctic Slope Regional Corporation lands.
Early 1990s	Last of the National Petroleum Reserve-Alaska leases from the initial leasing program are relinquished.
1994	Discovery of the Alpine field.
1998	Northeast National Petroleum Reserve – Alaska IAP/EIS ROD signed.
1999	Lease sale held in Northeast National Petroleum Reserve – Alaska.
2000	Alpine production begins.
2001	Northstar field begins production; development of Liberty field suspended; Phillips (successor of ARCO) announces discoveries in National Petroleum Reserve – Alaska.
2002	Lease sale held in Northeast National Petroleum Reserve – Alaska.
2003	Beaufort Sea Sale 186 held.
2004	Northwest National Petroleum Reserve – Alaska IAP/EIS ROD signed.
2004	Lease sales held in Northwest National Petroleum Reserve – Alaska.
2004	Alpine Satellite Development Plan EIS ROD signed.
Source: NRC (2003) and USDOI BLM (2004a).	

More recent fields have generally been developed in areas adjacent to existing producing areas, reducing the amount of additional support infrastructure (roads, pipelines, and processing facilities) needed to support additional production. At the same time, changes and improvements in technology have generally decreased the physical disturbance caused by more recent exploration, development, and production activities.

The Native population of the North Slope has established seven large communities from Kaktovik in the east to Point Hope in the west, and numerous smaller settlements for temporary occupancy. From these settlements, hunting and fishing areas (traditional subsistence use areas) extend across the landscape and coastal waters of the Chukchi and Beaufort seas. Of the four communities in proximity to the Planning Area, only Nuiqsut is (or will soon be) surrounded by oil development. Barrow, the largest village on the North Slope, is approximately 130 miles from Prudhoe Bay. The area of proposed oil leasing lies between the subsistence use areas of Barrow and Nuiqsut.

With expansion of the Alpine oil field, Nuiqsut will have oil field development extending farther into its subsistence use area. As future oil field development occurs in the Planning Area, the other North Slope communities would have oil field development closer to their villages, with an increasing likelihood of interaction between industrial activities and their subsistence use areas

The following section discusses the history of exploration and development on the North Slope, and is summarized from information in NRC (2003) and in the *Geology and Exploration of the National Petroleum Reserve – Alaska, 1974 to 1982* (Gryc 1988).

Pre-1900s

Oil seepages that are seen today along the Arctic Coast, from Skull Cliff on the Chukchi Sea to Brownlow Point on the Beaufort Sea, were the first evidences of potentially significant petroleum deposits on the North Slope of Alaska. Especially important were the active ponds of oil and layers of tar at Cape Simpson, just east of Barrow, likely known to the native inhabitants long before recorded history. In 1881-1883, John Murdoch, a member of the U.S. Navy's International Polar Expedition, visited Point Barrow and vicinity, and in 1892 reported that the expedition heard stories of a lake of tar on an island a 1 day sail east of Point Barrow, most likely Camp Simpson (Murdoch 1892). In August of 1886, the first non-native people to see the Cape Simpson seepages could have been Charles Brower and his partner Patrick Grey while on a hunting trip (Brower 1942). The North Slope's potential as a significant oil province was further shown when Ensign W.L. Howard found a pebble-sized piece of oil shale along the Etivuluk River in 1886 (Smith and Mertie 1930).

1900 to 1940

In 1904, W. Peters and F. Schrader, a topographer and a geologist, published the first recorded systematic geologic and geographic traverse of the Brooks Range and the North Slope (Schrader and Peters 1904). In 1901, the researchers traveled by way of the John, Anaktuvuk, and the Colville rivers, naming and describing the Lisburne Formation of the Mississippian age and the Cretaceous rocks in the area. They noted the anticlinal structures in the foothills of the Brooks Range and numerous coal seams along the Colville and Anaktuvuk rivers. They also described the coal exposures along the northwest coast, which were mined by Alaska natives and whalers for many years.

From 1906 to 1914, E. Leffingwell mapped the Arctic Coast east of Barrow and much of the inland area of what is now the Arctic National Wildlife Refuge (Leffingwell 1919). He described and named the rock formations that were later discovered as the oil-bearing rocks at Prudhoe Bay and noted the seepages at Cape Simpson. He concluded that, "Even if an oil pool were found in the northern region, there is serious doubt of its availability under present conditions, though it might be regarded as a part of the ultimate oil reserves that would some time be developed."

From 1909 to 1921, individuals and industry representatives staked claims, under the old mining laws, at Cape Simpson, Peard Bay, and along the Meade, Kukpowruk, and Kokolik rivers. During that time, large deposits of oil were discovered in Oklahoma and Texas and industry shifted their interest to those new places of production rather than the North Slope (Van Valin 1941).

About 1920, the U.S. Navy began to convert their engines from coal to oil, and an oil shortage was already being predicted. In 1923, in order to provide for the increased oil needs, the Naval Petroleum Reserve No. 4 (PET-4) was established by Executive Order No. 3797-1. The early reporting of oil seepages at Cape Simpson, Ensign Howard's discovery of oil shale along the Etivuluk River, the description of resources found in the North Slope by Peters and Schrader, and Leffingwell's mapping of the area, were all used to decide on the borders of PET-4. However, the geology and the geography of the PET-4 interior areas were still largely unknown, and it was necessary to increase the level of mapping and data gathering on the area.

From 1923 through 1926, USGS parties crossed the Brooks Range and PET-4 and mapped the geology and geography along many of the larger rivers, including the Kuk and Utukok rivers in the west and the Etivuluk, Killik, and Colville rivers in the east (Smith and Mertie 1930).

The USGS team, P. Smith and J. Mertie, also analyzed the petroleum potential of the Reserve. They concluded that the best possible sources of petroleum were in the apparently widespread oil shales, while the sources of oil in the Paleozoic rocks were problematic. They did not believe the Cretaceous rocks held much potential for petroleum, as they thought the rocks were small and sparse. Additionally, they concluded that the Cretaceous source rock in the Brooks Range was too deep for practicable drilling. They recommended that evaluating the petroleum potential in the PET-4 would be best realized by drilling for stratigraphic and structural information near Cape Simpson, and then by pursuing additional geologic field studies and drilling in other favorable areas.

1940 – 1968

Government-Sponsored Exploration and Development Activities

In 1943, the Bureau of Mines sent a field party to the North Slope to investigate oil and gas seepages, in response to inquires from the Alaska Defense Command and Territory of Alaska officials. The field party examined and sampled the Cape Simpson seepages, as well as several additional sites along the Arctic Coast. Samples were collected from 12 separate sites, and seepages were confirmed along Skull Cliff, Dease Inlet, Cape Simpson, Fish Creek, Brownlow Point, Manning Point, and Umiat Mountain.

In 1944, the first modern program of exploration, drilling, and geophysical and geological surveys was started by the U.S. Navy, and USGS geologic traverses began along the Colville River, later expanding to all major north-flowing rivers of the North Slope. In 1946, overland travel was necessary for the detailed structural geologic mapping. Weasels, military-style tracked vehicles were used to cross the Brooks Range by four different routes, covering much of interior area of the PET-4. By 1950, almost every stream capable of floating by boat was also traversed. Helicopters were first used for geologic studies in the Anaktuvuk Pass area; aerial photographs of over 70,000 square miles of the PET-4 and adjacent areas helped geologists interpret the possible geologic structure of the area, and a special series of photos were also used to analyze and plan field surveys by the USGS.

Between 1945 and 1952, geophysical studies, including experimental airborne magnetometer and gravity and seismic surveys, were completed and covered a large part of the Reserve. The seismic surveys covered about 67,000 square miles, which included areas outside of PET-4, the gravity-meter surveys covered about 26,000 square miles, and the airborne magnetometer surveys covered 75,000 square miles, nearly all of the ACP and much of the foothills of the North Slope. Travel and housing of the geophysical crews was by tractor-sled trains, smaller tracked vehicles, and small aircraft.

In 1944, the first drilling locations were determined by the presence of the seepages at Cape Simpson and a reconnaissance of the Umiat Anticline. It was decided that drilling should be limited to depths less than 10,000 feet, thought to be the economic limit at the time. In February and March of 1945, supplies were sledded to Umiat, where a drilling and logistic support camp was established and drilling began. The Umiat oil field, however, was not discovered until 1950, and still remains undeveloped. However, Umiat is still an important operating base for air transportation and geophysical and geological operations.

Also in 1945, 31 shallow core tests were drilled at Cape Simpson. Oil was produced, but the estimated reserves were considered too small to justify additional development. By 1948, geophysical surveys indicated the presence of a large basement high under the Barrow high and led to drilling near the top of the high. Gas was discovered, but neither oil nor hard rock basement was found at a depth of 2,500 feet. This area is now referred to as the Barrow Arch, the north limb of the Colville Basin.

In 1949, high sulfur, heavy oil was found at a test well drilled near the Fish Creek seepage at a depth of 3,000 feet. However, no structure was found and no reserve estimate was made, and continued geophysical exploration around the Barrow high found no significant oil reserves. Given the discovery of oil at Umiat, and the mapping of several closed anticlinal structures in and adjacent to PET-4, it was thought that further potential was in the northern foothills. Therefore, 10 shallow test holes were drilled on 6 structures; 1 gas field and 3 prospective gas fields were discovered; and 2 closed structures were mapped in the western part of PET-4. Test wells were drilled, one, Meade, of which showed strong gas, and one, Kaolak, of which was dry.

From 1945 through 1952, 45 core tests and 36 well tests were drilled within and adjacent to PET-4. The results showed one large oil field, Umiat, one large gas field, Gubik, one small gas field, Barrow, three prospective gas fields, Mead, Square Lake, and Wolf Creek, and two small oil deposits, at Cape Simpson and Fish Creek.

In 1947, the U.S. Navy, Bureau of Yard Docks, established and developed a research facility in the Seabee (Navy Construction Battalion) detachment, at Barrow. This was an important development for the Barrow community and for the exploration and development of the North Slope petroleum reserves. By May of 1947, a building program began to provide housing and laboratory facilities for the Arctic Research Laboratory (ARL), Office of Naval Research (ONR), and in August of 1947, ONR occupied these new facilities. To more fully acknowledge the U.S. Navy's contribution to Arctic research, ARL became the Naval ARL (NARL) in the mid-1960s.

In 1949, the discovery of gas at Barrow was likely the most significant result of the PET-4 project to the people of Barrow. The South Field is the oldest producing gas field in Alaska and the South and East Gas fields are the farthest north producing oil or gas fields in North America. When the PET-4 project arrived in 1944, Barrow was home to about 400 inhabitants; the exploration activities provided employment opportunities for the local people and the population quickly increased.

In 1953, the PET-4 program was unexpectedly halted. By then, additional drill sites had been selected and supplies had started to arrive at a location east of PET-4, in the southern foothills near the head of the Shaviovik River and at another location at the head of the Utukok River in the southwest corner of the Reserve. Most of the supplies were later returned to Barrow and Umiat.

In 1964, Congress granted permission to extend the gas supply to Barrow, and the village was completely converted to natural gas by 1965. The gas was supplied by the U.S. Navy at a subsidized cost and use was unlimited, which the Barrow community was dependent on for heat and power.

After the PET-4 program was recessed in 1953, the entire camp facility was turned over to ONR until December 1954, when the Air Force took over the management of the base camp to support the DEW-Line program. The Air Force continued to operate the base camp through civilian contractors until October 1971, when the operation was returned to the U.S. Navy. During that period, ONR continued to manage the laboratory through a contract with the University of Alaska.

In 1980, the NARL was decommissioned and the camp and all facilities were turned over to the USDOI. From 1980 through 1984, the laboratory and camp facilities were managed by the USGS and their contractor, primarily as a base of operation for the Barrow Gas Fields. In 1984, NARL and the base facilities were tuned over to the local native corporation, Ukpeagvik Iñupiat Corporation (UIC).

State and Federal Leasing and Industry-Sponsored Exploration Activities

In the mid- to late 1950's and early 1960s, a number of factors led to the beginning of industry actively exploring the North Slope for oil and gas resources. Although industry was aware of and interested in the North Slope, the lack of land availability, remoteness, and high costs associated with operating in the area precluded industry participation.

The factors that contributed to the entry of industry into the North Slope exploration scene were an overall encouragement of regional geological studies, the PET-4 program, the discovery of commercial quantities of oil and gas in Cook Inlet, and the end of the land availability moratorium on the North Slope, the latter of which was likely the most important factor in attracting industry to the area. The oil and gas found in the Cook Inlet demonstrated that it was economically feasible to explore for, develop, and sell hydrocarbons in and from Alaska. In 1957, ARCO made the initial discovery of Alaskan oil at Swanson River, on the Kenai Peninsula, which contributed significantly to Alaska statehood in 1959 and provided incentive to industry for the exploration of other sedimentary basins in the state.

After the federal government's decision, through the BLM, to make lands available for leasing, a total of 18,862 leases were offered in sales held in 1958, 1964, 1965, and 1966 (Jamison et al. 1980). Most of the sales were to the east and southeast of PET-4, however the lease sale in 1966 contained 3,022,716 acres to the west of PET-4.

In addition to the federal government lease sales, the State of Alaska selected 1,616,745 acres across the northern tier between the Colville and Canning rivers, to be offered for lease between 1964 and 1967. In 1964, the State's first lease sale on the North Slope offered 650,000 acres in the Colville River Delta area, and 196 tracts totaling about 475,000 acres were leased. In 1965, the State's second North Slope lease sale offered 754,000 acres, and 151 tracts totaling 380,000 acres were leased. Richfield-Humble acquired 28 blocks on what is now the crest of the Prudhoe Bay oil field, and British Petroleum acquired 32 blocks on the flanks. During the third State lease sale, in 1967, Richfield-Humble acquired 7 of the 13 tracts offered and leased; the 7 tracts covered the remainder of the crestal area of the Prudhoe Bay field.

In 1958, Sinclair operated a 3-month field program out of Umiat in preparation for the federal lease sale that year. In order to gain a better understanding of the subsurface geology and the hydrocarbon potential of the region, many companies began to gather geological data during summer field programs and geophysical, primarily seismic, during winter seismic operations. Following Sinclair, an average of five to seven companies were in the field during the 1959 through 1961 seasons, and up to 10 companies per year were operating geological field programs from 1962 through 1964. Field programs began to decline after 1964 and only two or three companies were in the field per year.

In 1962, Sinclair and BP operated the first industry program, with the first seismic season consisting of about 6.5 crew-months. The crew-months grew to about 29 in 1963, peaked at about 53 in 1964, and decreased to about 27 in 1965. There was little seismic acquisition between 1965 and 1968, until the season following the Prudhoe Bay discovery (discussed below).

In 1963, industry began exploratory drilling, based on leasing, geologic field work, and seismic acquisition. A total of 11 dry wells were drilled between 1963 and 1968. Colorado Oil and Gas Company drilled the first well in the Gubik area, followed by seven other dry wells, all of which were drilled on leases acquired in the first round of federal lease sales. The wells were located in the foothills, within 30 miles of either the Umiat or Gubik discoveries, near the areas that had shown the most promise during the Navy's previous exploration efforts.

After the initial failure of the drilling programs in the Umiat-Gubik area, industry shifted efforts to the north and east areas of the North Slope. During 1966 and 1967, Sinclair and Union each drilled a well on the eastern flank of the Colville High; both wells were dry. During the same period, ARCO-Humble drilled another dry well, Susie No. 1, in the northern foothills of the Brooks Range. The decision was made to take the rig 60 miles north to drill in the Prudhoe Bay area, rather than releasing the rig and ceasing any further drilling.

In April of 1967, drilling began for Prudhoe Bay State No. 1. In January of 1968, ARCO-Humble announced the discovery of oil and gas with a recoverable economic reserve estimate of 9.6 Bbbl of oil and 26 Tcf of gas.

At this time, there were little to no geologic and seismic programs on the North Slope and, other than Prudhoe Bay State No. 1, all drilling activity had ceased. However, with the discovery at Prudhoe Bay, and the State's announcement for an additional lease sale in the fall of 1969, industry substantially increased the level of exploration activities on the North Slope. The geological and geophysical programs surpassed the 1967 levels to 12 geological crew-months and 24 seismic acquisition crew-months in 1968 and 20 and 97 crew-months, respectively, in 1969 (Jamison et al. 1980). Additionally, in 1969, several other oil accumulations were discovered: the Kuparuk, West Sak, and Milne Point fields.

In September of 1969, the Alaska State Competitive Lease Sale No. 23 was held, offering 179 tracts totaling 450,858 acres—the unleased portion of the State's 1,600,000-acre allotment for the Statehood Act. With an average price per lease of $2,181.66 per acre, high bids on the 164 of the 179 tracts totaled more than $900,000,000. This was the last sale on the North Slope for 10 years (ADNR 2001a).

1969-2004

Between 1969 and 1979, there were no additional lease sales held on the North Slope or the adjacent waters of the Beaufort Sea, making land accessibility the limiting factor for industry activity. Beginning in 1979, however, the shallow State waters and federal OCS areas of the Beaufort Sea were made available through a series of lease sales, and additional onshore sales were held in the Colville-Canning area. The State offered 71 tracts (341,140 acres) and granted leases on 62 tracts (296,308 acres). This sale marked the first major venture into offshore leasing in the Arctic by either the State or federal governments.

In the 1980s, 1999, 2002, and 2004, the federal government, through the BLM, opened portions of the National Petroleum Reserve – Alaska to leasing. Although there are Native inholdings, and a land trade with Native corporations was considered in the mid-1980s, the Arctic National Wildlife Refuge has never been opened for leasing. Also, at various times, the ASRC made portions of their lands available to companies under exclusive exploration/leasing agreements.

Table 4-32 lists the discoveries, date of initial production, and 2003 production and reserves for oil and gas fields on the North Slope. Individual oil pools have been developed together as fields that share common wells, production pads, and pipelines. Fields have been grouped into participating areas (or production units) sharing common infrastructure, such as processing facilities, roads, and pipeline systems. Table 4-33 provides information on the existing infrastructure**.** A map showing the location of these developments and the general infrastructure interconnecting them is shown in Map 3-3. All of these fields, with the exception of Northstar, Endicott, Sag Delta North, and Eider, are onshore on state leases**.** The Niakuk, Point McIntyre, and Badami oil pools are mainly offshore, but are produced from onshore sites. If the Point Thomson field, which is included in the list of future projects, is developed, it is expected that the proposed Point Thomson pipeline would tie into Badami's common-carrier pipeline.

The following discussion of the post-Prudhoe Bay activity focuses on four geographic areas that have different degrees of accessibility and economics. These are the Colville-Canning area/shallow State waters, the Beaufort Sea OCS, National Petroleum Reserve **-** Alaska, and the 1002 Area of the Arctic National Wildlife Refuge. The onshore areas frequently contain some combination of state/Native or federal/Native land ownership.

Colville-Canning Area/Beaufort Sea State Waters

Through the 1970s, the area between the Colville and Canning rivers, from the Beaufort Sea south to the Brooks Range, was the sole area of industry exploration on the North Slope. Because of limited land availability and the success at and near Prudhoe Bay, this area has been the focus of exploration activity since the discovery well was drilled in 1968. The bulk of exploration and drilling has been concentrated in the northern portion of the area, near Prudhoe Bay and east and west along the coastline, following the structural trend of the Barrow Arch. The State leasing program that began in 1979, in the shallow state waters of the Beaufort Sea, is generally confined to a 3-mile-wide strip seaward from the shoreline and from Barrow to the Canadian border. The issue of ownership becomes somewhat irregular in the vicinity of the barrier islands and major inlets.

Seismic activity was at a high in 1970 with 96 crew-months. This decreased to 8 crew-months in 1972, and then grew back to 54 crew months in 1974. Following the high level of activity generated by the Prudhoe Bay discovery, geological and geophysical crew activity decreased sharply in the early 1970s and then slowly increased and stabilized by the late 1970s. In the early 1970s, geological field programs averaged about 20 crew-months per year. By 1974, this decreased to 6 crew-months and averaged 5 to 6 crew-months through the remainder of the 1970s (Jamison et al. 1980). During the 1980s and 1990s, the amount of fieldwork varied considerably, but the activity never reached the levels seen in the 1960s and 1970s. Over the last decade, geological activity has averaged 1 to 3 crew-months per year. Unlike seismic acquisition and exploration drilling, geological field activity frequently takes place external to the principal area of exploration interest. Much of the fieldwork was carried out in the Brooks Range to the south and in the Sadlerochit and Shublik Mountains of the Arctic National Wildlife Refuge.

Seismic activity was at a high in 1970 with 96 crew-months, decreased to 8 crew-months in 1972, and grew back to 54 crew-months in 1974 (Jamison et al. 1980). In the late 1970s, seismic activity averaged about 25 crew-months per year. Since 1980, the level of seismic acquisition has varied, but likely averaged less than 20 crew-months per year. One of the major reasons for this decrease has been the departure of several companies and the merger of former competitors. Also, the existing regional seismic grid was found to be of sufficient quality to allow companies to more finely tune their seismic acquisition and focus on specific areas. The more recent seismic acquisitions tend to be 3-D programs that provide a more detailed image of the subsurface than do the 2-D surveys. Seismic 3-D programs are too costly to be acquired on a truly regional scale and are generally limited to a maximum of 500 to 600 square miles.

From 1970 to the present, there have been 35 discoveries on state lands (ADNR 2001b). These range from the currently uneconomic Kavik (discovered in 1969) and Kemik (discovered in 1972) gas fields in the east-central portion of the Colville-Canning province to large oil discoveries at Endicott (discovered in 1978) and Alpine field (discovered in 1994). A significant undeveloped resource is the Point Thomson oilfield (discovered 1977)[1]. The field is located just to the west of the mouth of the Canning River and contains reserves estimated at 5 Tcf of gas and 360 MMbbl of oil.

Twenty of the 35 discoveries are either developed and on production, or are currently being developed (i.e., Northstar, located offshore). At least seven or eight of the discoveries are satellite fields and would not have been developed if they were not adjacent to a large field with an existing infrastructure. Tabasco and the Midnight Sun/Sambuca fields are satellites, each of which has oil reserves of 30 to 70 MMbbl.

The most recent fields to be developed in this region are associated with the Alpine oil field. The Alpine oil field encompasses approximately 890,000 acres of federal, state, and private lands in the central ACP of the North Slope. This area includes the Colville River Delta and the portions of the Tingmiaksiqvik River, Judy Creek, Fish Creek, Kalikpik River, and Kogru River drainages in the easternmost part of the Planning Area. During 1996, ARCO announced that the Alpine Prospect in the Colville River Delta was producible and contained an estimated 365 MMbbl of oil. More recent estimates of Alpine oil field reserves, however, are near 500 MMbbl. In November of 2000, production began in the Alpine field and approximately 105,000 bbls of oil are produced per day; there are plans to expand the facilities to handle up to 140,000 bbls of oil per day.

Alpine field oil reserves are extracted from two production pads (called CD-1 and CD-2) that are connected by a 3-mile long road and an oil processing facility has been constructed at CD-1. Infrastructure at the existing CD-1 pad fully supports the ongoing drilling and production operations, including activities at the CD-2 site. Facilities and equipment currently installed include processing facilities, production wells, camp facilities, sanitation utilities (water and wastewater), a drilling mud plant, an airstrip, a maintenance complex, warehouse buildings, disposal wells, an emergency response center, and communications, power generation, and various mobile equipment (USDOI BLM 2004c). Oil is transported through a 34-mile pipeline to a CPF in the Kuparuk River Unit, where Alpine field oil production is commingled with that of other fields in the area. Alpine field oil is then transported via the main Kuparuk River Unit pipeline to Pump Station 1 of TAPS. The Alpine oil field pipeline to the Kuparuk River Unit crosses under the Colville River channel. Ice roads and bridges provide access during the winter; otherwise there are no overland routes to this isolated field. There are no gravel roads connecting the road system in Kuparuk River Unit to the Alpine oil field. The footprint of the Alpine oil field infrastructure, excluding the pipeline to the Kuparuk River Unit, is approximately 100 acres.

Since the first commercial discovery at Prudhoe Bay in 1968, a total of 39 discoveries have been made on State leases and 24, nearly all in the immediate Prudhoe-Kuparuk area, were or are being developed. This area has been, and will continue to be, the primary exploration grounds until or unless large, attractive areas of the National Petroleum Reserve - Alaska and/or the Arctic National Wildlife Refuge become available for leasing.

[1] It is worth noting that in the 2000 State lease sale, one of the bidding groups acquired a substantial tract of leases in the Kavik-Kemik area. They picked up all of the leases, except those held by the discovery wells, which had been surrendered by previous lessees. The possibility of a gas pipeline from the North Slope has changed the perception of those discoveries. The wining companies are betting that the gas reserves are larger than previously estimated.

Federal OCS and Beaufort Sea

The Beaufort OCS lands were unavailable to industry until the joint State of Alaska/federal lease sale of 1979, which, along with subsequent sales, provided access to waters beyond the 3-mile limit, stretching from Point Barrow in the west to the Canadian border in the east. Including the 1979 lease sales, the Beaufort OCS has been the site of eight lease sales over a 20-year period. The most recent sale was held in 2003 (ADNR 200la, USDOI MMS 2001b). Over 720 leases have been issued in the Beaufort Sea, totaling 3.7 million acres.

The data acquisition issue is somewhat different in the case of the OCS regions. There is little or no geologic field work conducted exclusively for the purposes of developing a better understanding of the offshore subsurface geology. Rather, the subsurface well control from onshore drilling activities and secondarily outcrop geology is tied into the seismic grids to extend the geologic interpretations into the offshore areas and assist in the definition of potential prospects.

Seismic acquisition in the OCS is not well documented; however, commencing in the mid- to late 1970s, both summer marine and winter ice programs were acquired to correlate the better explored and understood onshore geology into the Beaufort Sea. Most, if not all, of the existing seismic data are 2-D, with little if any 3-D acquisition outside of the areas of existing discoveries or prospects that are being prepared for drilling within the next few seasons. While the per season or total line miles are not known, the totals are easily in excess of 5,000 line-miles.

The existing seismic grid extends across state waters and ties into onshore wells or wells in the shallow near-shore portions of the Beaufort Sea. The acquisition area extends from near Point Barrow on the west to near the Canada border on the east.

The first OCS exploration well was the Beethy Point No.1 in 1981, and the most recent exploration well was the Warthog No. l in 1997. The peak of exploration drilling was in 1985 through 1986, when 11 of the 30 exploration wells were drilled. A secondary drilling mode occurred during 1991 through 1993, when seven wells were drilled. In 1997, two exploration wells were drilled, the only since 1993 (USDOI MMS 2001b). Phillips Alaska, Inc., planned to drill an exploration well on its McCovey Prospect in 2001, but was unable to drill the well because of permitting problems.

Depending on water depth, the OCS exploration wells are either drilled from man-made ice islands or large, heavy, bottom-anchored, ice-resistant drilling rigs. If a discovery is made and the field developed, a more permanent structure is built to provide the base for long-term operations.

Eleven of the OCS exploration wells are determined to be capable of production (USDOI MMS 2001b). Of these, five are termed significant discoveries, of which four are in the OCS waters: Tern/Liberty (discovered in 1983), Hammerhead (discovered in 1985), Sandpiper (discovered in 1986), and Kuvlum (discovered in 1992). The fifth well is the Northstar field (Seal well), which underlies both federal and state acreage (ADNR 2000, USDOI MMS 2001b).

Tern/Liberty, Sandpiper, and Northstar lie offshore from the well-established Kuparuk and Prudhoe Bay fields and their infrastructure. The Hammerhead and Kuvlum discoveries are well to the east of the Prudhoe Bay field, in relatively deep water. Hammerhead is offshore from the Point Thomson and Flaxman discoveries. The Kuvlum discovery is to the east of the Canning River and offshore from the 1002 Area of the Arctic National Wildlife Refuge. The Northstar field has been developed and began production in late 2001.

National Petroleum Reserve – Alaska

In 1974, the high prices of oil and the discovery of oil at Prudhoe Bay renewed interest in PET-4, later renamed the National Petroleum Reserve – Alaska. The U.S. Navy began a small exploratory program, and in 1975, the Navy awarded a 5-year contract to Husky Oil, Inc., to manage and conduct a full-scale petroleum exploration program in

PET-4. The focus of the exploration work was in the northeastern portion of the Reserve where it was believed that it would be most likely to encounter an extension of the Prudhoe Bay productive zones.

In 1976, the Reserve was renamed the National Petroleum Reserve – Alaska, oversight of the Reserve was transferred from the Navy to the USDOI, and the USGS was assigned several tasks, including (1) continuing the program of exploration begun by the Navy, (2) continuing operation and management of the Barrow gas fields, and (3) completing the cleanup program, begun by the Navy, of the Reserve and adjacent areas. Between 1974 and 1982, 28 test wells were drilled, and although indications of oil or gas were found in nearly all of the test wells, no deposits were found that warranted development. In addition, six exploratory and development wells were drilled in the Barrow area to supplement the local gas supply. Exploratory drilling by the USGS ended in 1981 when the National Petroleum Reserve – Alaska was opened up to leasing.

Nearly 15,000 miles of seismic survey was completed and interpreted between 1974 and 1982. Seismic activities covered 1,440 miles in 1976. In 1977, seismic surveys covered approximately 1,500 miles, primarily in the Foothills Province; this area and the Brooks Range were again explored in 1978 when 1,916 miles were surveyed. In 1979, 1,900 miles of seismic survey was obtained, including use of the Vibroseis method, rather than explosives. Much of the work was focused in the foothills area between Umiat and the western boundary near Icy Cape. In 1980, 1,096 miles of seismic surveys were run, with one party in the coastal area and the other in the foothills and Brooks Range. Most of these surveys were for fill-in reconnaissance. During 1980 and 1981, seismic activities slowed, as it became apparent that Congress would open the National Petroleum Reserve – Alaska to private exploration, which occurred in spring of 1981.

The federal leasing program in the National Petroleum Reserve-Alaska commenced in 1982 with two lease sales in January and May. Most of the acreage was located in the south and southeastern portions of the National Petroleum Reserve – Alaska. A total of 271 tracts, totaling 5,035,772 acres, were offered in the two sales, and 38 tracts, totaling 927,965 acres, were leased. The leased activity was focused in the areas west of Nuiqsut, west of Umiat, and west of the Lisburne well. In both sales, the lessees appeared to be pursuing Umiat play-types. In July of 1983, a third sale was held, where 84 tracts and 2,195,845 acres were offered, spread across the northern portion of the National Petroleum Reserve – Alaska; 20 tracts, totaling 419,618 acres, were leased (USDOI BLM 1990b). These tracts appear to have been selected to evaluate Prudhoe Bay play-types and were largely concentrated in the area between Admiralty Bay and the Chukchi Sea. A fourth sale was scheduled for July 1984, but was cancelled after no bids were submitted on the 64 tracts and 1,550,677 acres offered (Weimer 1987, Banet 1991).

The leasing in the early 1980s resulted in the drilling of only one industry exploration well within the National Petroleum Reserve – Alaska, located in the western portion about 40 miles south-southwest of Point Barrow. The hole was dry and all other plans to drill were abandoned.

After the discontinuance of leasing in 1984, a 15-year hiatus in leasing activity and exploration in the National Petroleum Reserve – Alaska took place. It was not until after the 1994 discovery of the Alpine field in the Colville River Delta area that the government recognized the renewed industry interest in the National Petroleum Reserve – Alaska. After the discovery of the Alpine field, and in preparation for pending sales in the National Petroleum Reserve – Alaska, the major participants in ongoing North Slope exploration began to conduct 2-D and 3-D seismic programs in the probable sale area. The total line-miles of seismic data acquired are not known. There were at least seven 2-D programs acquired between 1992 and 1997 totaling 2,615 line-miles. A single 3-D program was shot in 1996 and covered an area of 152 square miles (Konbrath et al. 1997). There were additional 2-D and 3-D programs acquired since 1997; however, the number of programs and coverage are not known.

The BLM re-instituted leasing in the Northeast National Petroleum Reserve – Alaska in May 1999, restricting the sale to the Planning Area. Approximately 3.9 million acres were offered, drawing 132 high bids on 861,368 acres. The bulk of the leased areas are in the vicinity of Nuiqsut and between Teshekpuk Lake and the Ikpikpuk River. After the 1999 sale (Sale No. 991), the industry began an extensive drilling program in the northeastern portion of the National Petroleum Reserve – Alaska. Three wells were drilled in the winter of 2000, and an additional six wells were drilled in 2001. Most, if not all, of these wells were probably targeting Alpine-style prospects. An additional sale was held in 2002, where a total of 60 tracts with 579,269 acres were leased. The leased acreage is generally to the south and west of previously acquired leases.

Following signing of the Northwest IAP/EIS ROD, the BLM held a lease sale in 2004 for 484 tracts of land within the Northwest National Petroleum Reserve - Alaska and another 22 tracts that are combinations of Northwest National Petroleum Reserve – Alaska and Planning Area lands, totaling approximately 5.8 million acres. Bids were received on 123 of the tracts, totaling 1,403,561 acres.

At least five of the wells drilled in the National Petroleum Reserve – Alaska have discovered oil and/or gas. The size of the discoveries has not been made public, but the operators have indicated that the oil reserves are at least equal to those of the Alpine field.

Arctic National Wildlife Refuge

The Alaska National Interest Lands Conservation Act (1980) established the Arctic National Wildlife Refuge (ANWR). In Section 1002 of that Act, Congress deferred a decision regarding future management of the 1.5-million acre coastal plain (1002 Area) in recognition of the area's potentially enormous oil and gas resources and its importance as wildlife habitat. A report on the resources (including petroleum) of the 1002 Area was submitted in 1987 to Congress by the USDOI. The 1002 Area of the Arctic National Wildlife Refuge has numerous active oil seeps, exposures of oil-stained sandstone, and large attractive structures. However, these lands are currently closed to industry and can only be opened for exploration and potential development by an act of Congress.

Because ANILCA prohibits it, there has been no leasing in the 1002 Area. However, in 1987, the Reagan administration proposed to trade land/exploration rights in the 1002 Area for Native corporation inholdings in National Parks and other sensitive areas. Six Native corporations were found qualified to participate and each chose an industry partner. The industry partners were to supply technical expertise and have exclusive right to explore any lands acquired by their Native corporation partners.

The federal government proposed and developed a tract selection/trade process and the Native corporations and their industry partners proceeded to bid on 71 complete or partial tracts; tracts were 4-square-mile parcels. Virtually all the prospective trade lands identified in the process were either along or to the east of the Marsh Creek Anticline. Unpublished industry evaluations tended to place a greater portion of the areas potential resources in the deformed area, including the Marsh Creek Anticline and areas to the east. This land trade, however, was never carried through to completion, nor were the lands transferred.

Data acquisition in the ANWR has been largely restricted to geological field parties in the Brooks Range, south of the 1002 Area, and to the limited seismic acquisition program conducted under government oversight in 1984 and 1985. These two seasons produced approximately 1,400 line-miles of mostly poor to moderately good data quality.

Since there has been no leasing within the 1002 Area, there has been no exploration drilling. However, Kaktovik Iñupiat Corporation holds surface title to some lands, and the city of Kaktovik lies within the boundaries of the refuge. British Petroleum/Chevron drilled a well on native lands through an exclusive exploration agreement with the Native corporation. The information from this well is held in confidentiality since it was drilled in 1986.

Furthermore, since there has been no drilling within the 1002 Area, there have been no discoveries. There were two discoveries, however, west of the Canning River that abut the 1002 Area. It is possible that either the Sourdough or Point Thomson fields may extend eastward into the 1002 Area. If and when they are developed, they may have the potential to drain oil and/or gas from beneath the Arctic National Wildlife Refuge.

Native Corporation Lands

The ASRC and its various village corporations have extensive land holdings across the slope. These extend from Barter Island in the east to the Chukchi Sea in the west and from the Beaufort Sea in the north to the crest of the Brooks Range in the south. The regional corporation and several of the village corporations have entered into

Table 4-32. Past, Present, and Reasonably Foreseeable Oil and Gas Development on the North Slope.

Unit/Area	Field/Satellite	Year Discovered	Year Began	Oil and Condensate			Natural Gas			Natural Gas Liquids	
				2003 (bbl)[1]	Cumulative (bbl)[2]	Reserves/ Resources (MMbbl)[3]	2003 (Mcf)	Cumulative (Mcf)	Reserve (Bcf)[3]	2003	Cumulative
Past Production and Development											
Duck Island	Endicott	1973	1987	9,104,149	419,868,726	162[4]	141,555,553	1,694,395,682	843	1,188,955	19,403,953
	Sag Delta North	1989	1989	--	--	--	--	--	--	--	--
	Eider	1998	1998	242,135	2,572,163	--	2,813,008	22,393,045	--	--	--
	Ivishak	--	--	91,649	7,917,658		64,026	6,487,744		604	111,333
Prudhoe Bay	Prudhoe Bay	1967	1977	141,301,777	10,570,908,475	3,024	2,840,910,387	45,301,397,532	23,879	24,972,399	419,564,568
	Lisburne	1968	1981	3,335,277	136,411,220	36	66,748,432	1,388,844,548		480,297	13,537,270
	Niakuk	1985	1994	4,599,262	76,464,287	44	3,385,803	64,418,997		38,543	910,971
	West Beach	1976	1994	9,769	3,356,041		201,454	19,952,910		1,061	219,730
	North Prudhoe Bay	1970	1993		1,984,791			6,616,438			84,599
	Pt. McIntyre	1988	1993	13,319,766	362,750,000	154	51,776,642	573,956,878		517,815	7,287,040
	Pt. McIntyre und.	1988	1997		33,480			30,008			600
	Midnight Sun	1998	1999	1,719,308	9,700,793	482[5]	3,499,585	33,901,582			
	Aurora	1999	2001	3,782,231	8,178,290		11,970,575	37,714,159			
	Borealis	1999	2001	11,790,725	21,574,963		9,465,803	20,082,471			
	Orion	2001	2003	368,058	465,163		311,963	369,868			
	Polaris	1999	2001	917,642	2,544,053		999,965	3,093,267			
	Niak IV-SR				65,388			504,427			
Kuparuk River	Kuparuk	1969	1981	58,536,233	1,918,003,873	1,031	107,454,326	2,284,395,578	611		3,345,638
	Tabasco	1992	1998	1,541,615	8,261,495	11	187,877	1,146,436			
	Tarn	1992	1998	12,342,736	54,248,115	83	12,834,804	77,122,641			
	West Sak	1969	1998	2,856,897	11,353,598	343	812,737	3,192,738			
	Meltwater	2000	2001	2,124,967	5,175,705	33	5,594,761	9,820,332			
	Palm	2001	2002			94					
Milne Point	Milne Point	1969	1985	11,602,243[6]	169,290,345[6]	503[7]	5,337,142	84,938,184	14		
	Cascade	1993	1996								
	Schrader Bluff	1969	1991	7,001,109	30,433,300		6,095,224	18,806,792			
	Sag River	1968	1994	101,470	1,541,239		121,173	1,568,098			
	Ugnu		2003	2,212	2,212		242	2,242			
Badami	Badami	1990	1998	281,552	4,347,065	0	3,697,960	22,891,313			
Colville River	Alpine	1994	2000	35,582,431	101,542,484	431	41,593,887	117,160,491	60		
Northstar	Northstar	1984	2001	22,968,022	42,136,227	191	70,861,557	121,163,273	450		

Table 4-32. Past, Present, and Reasonably Foreseeable Oil and Gas Development on the North Slope (Cont.).

Unit/Area	Field/Satellite	Year Discovered	Year Began	Oil and Condensate			Natural Gas			Natural Gas Liquids	
				2003 (bbl)[1]	Cumulative (bbl)[2]	Reserves/ Resources (MMbbl)[3]	2003 (Mcf)	Cumulative (Mcf)	Reserve (Bcf)[3]	2003	Cumulative
Past Production and Development											
National Petroleum Reserve Alaska	East Barrow	1974	1981				92,659	7,981,208	5		
	South Barrow	1949	1950				88,671	22,413,374	4		
	Walakpa	1980	1993				1,235,479	12,667,132	25		
	Umiat	1946			40536[8]	70[9]					
Total				**345,527,063**	**13,971,194,825**	**6,692**	**3,389,811,695**	**51,959,727,860**	**25,891**	**27,199,674**	**464,465,702**
Present Development and Production											
Colville River	Fiord (CD-3)	Present Development				332					
	Nanuq (CD-4)										
	Alpine West (CD-5)										
	Lookout (CD-6)										
	Spark (CD-7)										
Reasonably Foreseeable Oil and Gas Development											
Western Group	Kalubik	1992	Offshore			250					
	Thetis Island	1993	Offshore								
	Oooguruk	2003	Offshore								
	Nikaitchuq[10]	2004	Offshore								
Central Group	Gwydr Bay	1969	Offshore			320					
	Pete's Wicked	1997	Onshore								
	Sandpiper	1986	Offshore								
Eastern Group	Point Thompson	1977	Offshore			1,000					
	Liberty	1983	Offshore								
	Mikkelson	1978	Onshore								
	Sourdough	1994	Onshore								
	Yukon Gold	1994	Onshore								
	Flaxman Island	1975	Offshore								
	Stinson	1990	Offshore								
	Hammerhead	1985	Offshore								
	Kuvlum	1987	Offshore								
Undiscovered			Onshore			3, 660					

Table 4-32. Past, Present, and Reasonably Foreseeable Oil and Gas Development on the North Slope (Cont.).

[1] Annual production of oil in barrels (bbl) in 2003 (AOGCC 2004).
[2] Cumulative oil production in barrels (bbl) and natural gas in thousand cubic feet (Mcf) since discovery through 2003 (AOGCC 2004).
[3] Past Production and Development: Remaining reserves of oil in million barrels (MMbbl) and of natural gas in billion cubic feet (Bcf) as of December 2002 per ADNR Division of Oil and Gas (ADNR 2003), except where noted. Present Development and Production: Undeveloped reserves (MMbbls) from Alpine Satellite Development FEIS (USDOI BLM 2004c). Reasonably Foreseeable Oil and Gas Development: Resource estimates (1,570 MMbbls) for Western-Central-Eastern categories from Northwest IAP/EIS (USDOI BLM and MMS 2003). Resource estimates (MMbbls) for the Undiscovered Onshore category are from this document and the Northwest IAP/EIS (USDOI BLM and MMS 2003). Includes one-half of the resource of 2,054 MMbbls from Northeast National Petroleum Reserve - Alaska and one-half of 1,260 MMbbls from the Northwest National Petroleum Reserve - Alaska at $30 per bbl. Also includes 2.0 billion bbls from unnamed satellite fields.
[4] Endicott reserves include those in Endicott, Sag Delta North, Eider, and Ivishak.
[5] Includes reserves for the Prudhoe Bay satellites Midnight Sun, Aurora, Borealis, Orion, and Polaris.
[6] Milne Point includes Cascade annual and cumulative production.
[7] Combined Milne Point Unit.
[8] Total of oil produced on formation tests from Umiat test wells 1946-1952 (Collins 1958).
[9] Kumar, et al. (2002).
[10] Unit application approved April 29,2004 (ADNR 2004c).

Table 4-33. North Slope Oil Infrastructure (1968-2001).

	1968	1973	1977	1983	1988	1994	2001
Gravel Roads							
Oil field (miles)	0	100	139	294	358	370	400
Oil field (acres)	0	677	1,002	2,029	2,448	2,536	2,745
Dalton Highway (miles)[1]	0	170	170	170	170	170	170
Dalton Highway (acres)[1]	0	332	332	332	332	332	332
Gravel Pads							
Production, processing, support, exploration (facilities)	4	100	158	277	325	341	353
Production, processing, support, exploration (acres)	14	901	1,981	4,570	5,552	5,692	5,817
Airstrips	1	15	19	20	20	20	20
Airstrips (acres)	6	136	252	287	313	313	287
Offshore islands	0	0	2	12	15	16	17
Offshore islands (acres)	0	0	5	54	133	149	155
Gravel Mines							
In rivers (acres)	25	4,732	4,996	5,011	5,063	5,061	5,082
In tundra (acres)	0	34	151	745	1,179	1,186	1,283
Pipeline Corridors (miles)							
Oil field[2]	NA	NA	NA	NA	NA	NA	450
Trans-Alaska Pipeline[3]	0	166	166	166	166	166	166
Tundra Impacted Areas (acres)							
Gravel footprint areas[4]	352	2,045	3,620	7,354	9,013	9,225	9,557
Other impacted areas[5]	308	1,388	1,552	1,694	1,698	1,765	1,765
Gravel mines	25	4,766	5,146	5,756	6,241	6,364	6,364
Total Disturbed Area (acres)	685	8,200	10,319	14,804	16,952	17,354	17,686

[1] Does not include portions of the highway south of the North Slope.
[2] Multiple pipelines are included in some corridors, e.g., 366 miles have 1-5 pipelines and 73 miles have 6-11 pipelines.
[3] A buried gas pipeline roughly parallels the oil pipeline for 144 miles south to Pump Station No. 4; mileage only includes those on the North Slope.
[4] Includes gravel roads, gravel or paved airstrips, and offshore and onshore gravel pads/islands.
[5] Includes exploration site-disturbed area around gravel pad, exploration airstrip, peat roads, tractor trail, exploration roads, and gravel pad removed.
NA – Not available.
Source: NRC (2003).

exploration agreements with various petroleum companies. These agreements have generally required some form of initial monetary commitment, specific work commitments, and an agreement to lease potential acreage or forfeit the right to explore at an agreed upon date. One or more exploratory wells are also required if the company elects to go to lease.

There is no competitive leasing process utilized to make lands available to industry. The negotiations are generally confidential. Chevron, Texaco, ARCO, and Unocal have had such agreements in the past. Anadarko Petroleum and its partners currently have an exclusive exploration agreement with ASRC for nearly 3 million acres in the foothills of the Brooks Range.

The data acquired on Native corporation lands, especially seismic and geophysical data, are usually kept confidential, with the data only available to the corporation and its industry partners. However, with the recent interest in a gas pipeline, there is increased activity in the Brooks Range foothills, and the Native corporation lands are being reevaluated for both oil and gas. This has resulted in a recent increase and refocus of geologic field efforts in the foothills belt. Similarly, new seismic data were acquired during recent winter seasons. These seismic programs included both 2-D and 3-D acquisition technologies.

Through ASRC's exploration agreements with various companies, one exploration well was drilled on Native corporation lands on the North Slope (ADNR 2001b). Some of these Native corporation holdings are in the form of inholdings within national parks, national monuments, and wildlife refuges. This has afforded those companies with Native corporation exploration agreements the opportunity to drill and evaluate areas that are not otherwise accessible and are off limits to the rest of the industry. These wells were drilled on inholdings within the Arctic National Wildlife Refuge and the National Petroleum Reserve – Alaska, as well as in the foothills of the Brooks Range south of the state acreage in the Colville-Canning area. There were also wells drilled on ASRC lands to the west of the National Petroleum Reserve – Alaska and there was one discovery associated with ASRC lands in the Colville River Delta. The Alpine field extends beneath leases jointly held with the state and BLM.

Cleanup and Rehabilitation Activities on the North Slope

Concurrent with exploration in the 1970s was a greater awareness of the need to protect the Arctic environment from exploration activities and to clean up debris left from earlier exploration activities. Equipment and supplies that were previously hauled by D-8 Cat trains, sometimes during the summer with the blade down, were now moved in winter by rolligons—large vehicles with low-pressure balloon-like tires. In 1975, the Navy began preparing an EIS for activities in the northeastern portion of PET-4; this EIS would later expand to cover the entire Reserve and was completed in spring 1977. As part of the Final EIS, the Navy, in cooperation with the USGS, drew up stipulations concerning winter road and trail construction.

In 1976, drilling fluids from a site near Teshekpuk Lake broke through a retaining berm and flowed into Teshekpuk Lake. Although the amount of damage to the environment was minimal, all future reserve pits were designed to contain the total estimated volume of drill cuttings and muds below the level of the original tundra surface.

In 1976, a cleanup program was initiated, based out of Point Lonely and Barrow. During the summer of 1976, over 23,500 drums were retrieved and 750,000 pounds of debris collected. In 1977, another 26,500 drums and 485 tons of debris were collected. In 1978, over 2 million pounds of debris were collected, primarily from the Skill Cliff Air Force Tower site and the Navy’s Topagoruk and East Topagoruk test well sites. In 1979, another 1.8 million tons of debris were collected at old Navy sites and other sites in the National Petroleum Reserve – Alaska.

Rehabilitation of pads and other disturbed sites began in the late 1970s, with the focus on lowering the drill pads and obliterating their straight edges, filling reserve pits, and revegetating sites. Germination success varied depending upon growing conditions during the summer; wet and foggy summers usually resulted in poor germination. It is estimated that about 550 acres were disturbed during the 1975-1982 USGS exploration program, that revegetation was attempted on 440 acres, and that vegetation became well established on nearly 400 acres by 1982.

4.7.3.2 Present Development and Production on the North Slope and in the Planning Area (2005-2008)

Present Development and Production (within the next few years) includes fields that are in the final planning stages for development or are under construction but have not yet begun production (Table 4-32). Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes are likely to be revised as information is obtained during production operations. Because many new developments on the periphery of existing infrastructure would be tied to these facilities, continued operation of current production facilities and transportation systems is vital to new development projects.

The Alpine Satellite Development Plan would develop five new fields (CD-3 through CD-7) tied into the existing Alpine oil field infrastructure (USDOI BLM 2004c). This project is in the permitting stage, with the first of these satellite fields expected to be operational by 2007. The ADNR estimates the five pads, corresponding with former exploratory well locations, could produce a total of 330 MMbbl of oil in the next 2 decades (ADNR 2003). In August 2004, ConocoPhillips announced a proposed expansion of the CD-2 field, with original oil in place in the expansion area estimated at 31 to 55 MMbbl (Petroleum News Alaska 2004a).

Produced fluids would be transported by pipeline to the Alpine CPF for processing. Gravel roads would connect CD-4 through CD-7 to existing Alpine oil field infrastructure. Proposed field CD-3 would be constructed with a gravel airstrip, but without a gravel access road. Gravel used for construction of roads, pads, and airstrips would be obtained from the existing ASRC Mine Site and the Clover Potential Gravel Source. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. Proposed field CD-6 and its access road and pipelines would be within a 3-mile setback from Fish Creek, established by the 1998 Northeast IAP/EIS ROD (Lease Stipulation 39[d]). Consistent with the requirements of the 1998 Northeast IAP/EIS ROD, the Alpine Satellite Development ROD grants an exception to allow this infrastructure within the setback. Additional exceptions are granted to locate oil infrastructure within 500 feet of some water bodies (Lease Stipulation 41) and to allow roads between separate oil fields (Lease Stipulation 48). Aboveground pipelines would be supported on VSMs and would be at elevations of at least 7 feet above the tundra at VSMs. Powerlines would be supported by cable trays placed on the pipeline VSMs; cable trays would not hang below the pipelines. Both industry and local residents would use the gravel roads.

Other projects likely to come into production in the next few years include additional development at two drill sites in the Kuparuk River Unit West Sak oil field, where production would increase by approximately 45,000 bbl per day in 2007 (Petroleum News Alaska 2004b).

4.7.3.3 Reasonably Foreseeable Future Development and Production (Within the Next 20 Years)

Reasonably Foreseeable Future Development and Production includes projects that are reasonably foreseeable to begin development within the next 20 years. These projects could develop discoveries that are listed in Table 4-32; however, many of the listed discoveries were made decades ago and have remained non-commercial to this day. Development of these discoveries would depend largely on technology advancements and higher petroleum prices. The developments most likely to occur would be near existing fields, so infrastructure systems could be shared.

Additional amounts of oil could be produced by enhanced recovery technology from existing fields and from undeveloped (or undiscovered) satellite pools adjacent to existing production areas. Some of this production would replace declining production at existing fields. Although the extent of both of these new resources (reserve growth and satellites) is as yet undetermined, it is reasonable to assume that a portion would be brought into production in the next 20 years. It is assumed for analysis that half of the 4 Bbbl estimated for enhanced recovery and satellite fields would be brought into production in the foreseeable future. Because enhanced recovery and satellite fields would be developed largely from existing infrastructure, the incremental addition of new infrastructure and related land disturbance is expected to be minimal.

The full-field development scenario for the Alpine Satellite Development was included under reasonably foreseeable future development/production for the *Alpine Satellite Development Plan EIS* and in the assumptions made for the cumulative effects analysis for this amendment. Under the full-field development scenario, 2 additional CPFs (with production facilities), and 22 additional production pads, could be constructed in the Alpine Satellite Development Area. Gravel roads would connect all pads except four pads in the lower Colville River Delta (downstream from the existing CPF), and one pad near the Kogru River. Production pads not accessed by roads would be accessed by air, and would have gravel airstrips. Although considered reasonable foreseeable for purposes of this amendment, it is uncertain whether the oil and gas resources would be discovered in the future.

Northwest National Petroleum Reserve - Alaska

The *Northwest National Petroleum Reserve – Alaska IAP/EIS* evaluated the potential for oil and gas development in the Northwest National Petroleum Reserve – Alaska (USDOI BLM MMSA 2003). The January 2004 ROD resulted in the opening of all BLM lands within the Northwest National Petroleum Reserve-Alaska to oil and gas leasing with the exception of 1,570,000 acres in the Wainwright area that were deferred for 10 years, and 440,000 acres in the Colville River Special Area were that deferred until a Colville River Management is completed. This left approximately 77 percent of the Northwest National Petroleum Reserve - Alaska open to leasing.

The Northwest National Petroleum Reserve – Alaska has a much lower economic potential on a per-acre basis than the Planning Area. The Northwest National Petroleum Reserve – Alaska is over twice as large as the Planning Area, but has only an estimated 31 percent of the combined total oil resources, and 46 percent of the combined total gas resources found in the National Petroleum Reserve - Alaska. The Northwest IAP/EIS predicted that under a high oil price ($30 per bbl) and a multiple lease scenario, as many as 36 exploration wells, 36 delineation wells, 12 production pads, and 295 miles of pipelines would be constructed (USDOI BLM MMS 2003). Under this scenario, up to eight fields are expected to be developed and would produce up to 1,260 MMbbl of oil, with a peak oil production of 50 MMbbl per year.

South National Petroleum Reserve - Alaska

The BLM intends to prepare an IAP/EIS for the South National Petroleum Reserve - Alaska to determine the appropriate management for these 9.2 million acres of federal lands located southwest of the Planning Area. The IAP/EIS would determine what lands would be made available for oil and gas leasing and for exploration and potential development of coal and hard rock mineral resources.

Although it is unlikely that the South National Petroleum Reserve - Alaska has oil resources equivalent to the volumes thought to occur in the Planning Area, the natural gas potential is relatively high. Presently, all natural gas on the North Slope is stranded as there is no natural gas transportation system for delivering the product to markets. However, exploration and production of natural gas could occur in the South National Petroleum Reserve - Alaska if a gas pipeline was constructed to transport the gas from the North Slope. The construction of such a pipeline, and the consequential development of North Slope natural gas resources, is considered speculative at this time (see Section 4.7.3.4, Future Gas Development).

The South National Petroleum Reserve - Alaska may contain important hardrock mineral deposits. A series of high-grade lead-zinc-silver veins are believed to occur in the South National Petroleum Reserve - Alaska. Phosphate rock resources, with an indicated volume of 15.7 tons, are thought to occur in the Upper Cretaceous Lisburne Group to the east of the South National Petroleum Reserve - Alaska and these same geologic formations extend westward across much of the southern portion of the South National Petroleum Reserve - Alaska. Seven barite occurrences hosted by the Permian Siksikpuk Formation have been identified and industry has expressed interest in development of these resources. Occurrences of uranium would also be expected in this geologic environment.

The South National Petroleum Reserve - Alaska could also contain coal resources located within the Nanushak Group formation, where coal seam thickness totals more than 300 feet. Martin and Hawley (1986) identified North Slope coal resources totaling 150 billion tons, the bulk of which lies within the National Petroleum Reserve-Alaska. Coal bed methane could also be associated with such coal deposits.

The National Petroleum Reserve - Alaska was closed to mining as part of the creation of PET-4 in 1923. This intent was reinforced by Section 102 of the NPRPA, which withdrew the area from all forms of disposition and entry under the mining laws. These laws would have to be changed for the BLM to lease lands within the South National Petroleum Reserve - Alaska for mineral exploration and development. Additionally, there are no transportation routes for the export of minerals, making development of these resources unlikely in the in the near term.

4.7.3.4 Speculative Development (Beyond 20 Years)

Speculative Development includes undiscovered (purely speculative) resources that may be developed beyond the foreseeable future (perhaps more than 20 years from now), including undiscovered oil resources that may be found as a result of future state and federal lease sales. Although the North Slope could continue to play a major role in meeting the energy requirements of the United States throughout the 21st century, several key elements will greatly influence the magnitude, stability, and duration of that role. Among the most significant of these factors are oil and gas prices, land availability, regulatory environment, and level of competition.

Prices

The price structure and stability for oil, and to a lesser extent gas, would play a pivotal role in the future of the petroleum industry in Alaska. With low oil prices, the high cost of producing a barrel of oil in Alaska places North Slope crude oil at a disadvantage relative to the OPEC cartel and other low-cost producers. It also tends to use up funding for Alaskan projects by the producing companies who can realize a greater return on investments in low-cost environments. When oil prices are higher, such as occurred in late 2004, the return on investment is much greater and exploration and development opportunities become more attractive to industry on the North Slope.

Land Availability

Even with sustained high oil prices, there will be no significant reserve additions without attractive exploration opportunities. These opportunities only exist when there is a continued and diverse offering of exploration acreage. A successful exploration effort requires that a broad mixture of potential play types of a size sufficient to provide economically viable targets be made available in a predictable and systematic manner. In such a scenario, exploration would provide a spectrum of field sizes such that the larger accumulations generate the demand for the infrastructure, which would in turn create an environment in which smaller fields (satellites) may be profitable to develop.

In the near future, the available relatively low-cost operating areas near existing infrastructure will have been reasonably well explored. They will be deemed to no longer have the potential to yield discoveries of sufficient size to replace the production lost due to decline of the older major fields. At that point, there would either be pressure to open additional lands to exploration or it would be acknowledged that the region's oil production is in decline and that reduced production would eventually lead to the shutdown of operations and the TAPS pipeline.

Prediction Versus Reality

Apparent failure of early stage predictions, regarding reserve size, number of wells to be drilled, size of areas to be affected by development, and miles of roads and pipelines, can raise concerns (NRC 2003). Obviously, if anticipated potential effects are based on the early stage predictions, any significant deviation from those forecasts would result in a difference in the magnitude of any activity-associated effects.

The problem lies in the failure to recognize that each of these predictions, whether they are the number of oil fields in an area, the size of the accumulations, or the amount of infrastructure necessary, is based on very little solid scientific data. When exploration begins in a new area, like in the North Slope in the 1960s, no one has direct evidence of the true nature and distribution of potential reservoirs in the subsurface, let alone the presence or volume of hydrocarbons that may be present. Seismic data used to determine the presence of potential structures and traps, and outcrop exposures, often tens or hundreds of miles away, are the sole source of possible reservoir data. Based on these bits of information, a first prediction is made as to the probability of oil or gas being present, and then if the assumptions regarding structure, trap, reservoir, and source are reasonable, what range of hydrocarbon volumes the feature could contain. The reality of potential volumes, as revealed by exploration drilling, may be very different from the pre-drill predictions.

Prudhoe Bay was a definite surprise; it was much larger than expected and the vast bulk of the oil was found to be in a rock that was unknown as a reservoir target prior to drilling the well. Original predictions for the field were wrong; the second prediction at Prudhoe Bay was that the field contained 9.6 Bbbl (403.2 billion gallons) of recoverable oil, and subsequent planning for the field used that reserve figure. Now, advances in technology and geologic variability in the reservoir have placed current estimates of recoverable oil at 13 Bbbl.

Similar results have been noted at Kuparuk and Endicott fields, but the Lisburne field has not met expectations in terms of daily production rates or cumulative production. This is largely the result of applying the incorrect reservoir model to the field in its early stages. Predictions made at the time of the discovery of these fields did not recognize the upside that existed (or the downside in the case of the Lisburne field). As a result, estimates of the life span of the fields, size of areas to be affected, number of wells to be drilled, and other variables were not precise.

Additionally, the development of the infrastructure at Prudhoe Bay, Kuparuk, and TAPS made exploration for previously unrecognized or ignored nearby small accumulations feasible. This again contributed to a larger area of development than was forecast at the time of the original estimates. It must be recognized that these satellite fields were either unknown, not economic under then present economics, or were known to individual companies as a result of proprietary data which were not shared with competitors for obvious reasons.

These early estimates work both ways, as there tend to be more over-estimates of potential than under-estimates. The public generally never hears of these because the either the company drills a dry hole and abandons the project, or it acquires additional data that indicates the prospect is invalid or uneconomic and no drilling occurs. The most notable failure in north Alaska was the Mukluk well, the potential thought to rival Prudhoe Bay. Exploration, leasing, and drilling costs totaled as much as $2 billion; the well was drilled and abandoned as a dry hole.

Uncertainty and risk are the nature of the exploration business. Any company that is willing to spend the money and time to acquire data, lease land, and drill exploration wells is hoping for a discovery of a size sufficient to justify the costs and provide an adequate, competitive return on the investment. The company is also hoping that the field will provide the infrastructure to support possible nearby accumulations when and if they are found.

When an exploration company acquires a new lease or block of leases, it will often permit multiple well locations. In reality, only a fraction of these locations are normally drilled. This is due either to a failure to discover an economic accumulation in the most favored locales, or because the initial interpretation of the geology was incorrect.

Historically, the successful prediction of exploration and development activity (how much, when, and where) was an art as well as a science. Recent technological advances have resulted in much improved exploration success rates, but frontier areas still have high risks and failure rates. With the full awareness of this uncertainty, a range of potential and cumulative effects of future oil and gas activities can be addressed. The best approach is to use the knowledge derived from known activity, and its effects, and project a likely case into the future, with a series of scenarios that vary the future activity within reasonably constrained limits. Although this approach is still unable to guarantee when, where, and how much, it should provide the most reasonable range of estimates of the overall effects of future activities.

Among the speculative fields listed in Table 4-32 are some that were discovered 50 years ago and remain noncommercial today because of their very remote locations, low production rates, or the lack of a gas-transportation system. Because they are not likely to become commercially viable in the foreseeable future, the effects of development and production associated with these fields are not discussed in detail in the cumulative impacts analysis. A detailed discussion of cumulative impacts is not possible when a reasonable estimate of the location, size, or development schedule cannot be made.

Future Gas Development

Development of natural gas resources on the North Slope is considered speculative at the present time because there is no transportation system to move gas to outside markets. Numerous gas discoveries have been uneconomical to produce for several decades, and would remain undeveloped until a transportation system is constructed. The viability of a transportation system is questionable, and there is no guarantee than one would ever be built, despite the non-binding proposals by several pipeline development groups. The largest known gas accumulation on the North Slope is in the Prudhoe Bay field, with 46 Tcf originally in place and approximately 25 Tcf available for sale. Gas reserves from the Prudhoe Bay field would provide the backstop for a future gas transportation system, but would be insufficient to fully utilize the capacity of the new system for the decades of gas production needed to recover the project's cost. A gas export project (likely a pipeline) would rely on existing, shut-in gas resources, as well as new, large gas discoveries to supply a large-scale project lasting for more than 30 years. Most of the known gas resources are identified in oil fields on the North Slope, and no active exploration for new gas fields has occurred. When (or if) a large sale gas export project is constructed, exploration and development activities targeting new gas fields is likely to move into previously untested areas, both onshore and offshore.

The BLM and MMS 2002 oil and gas resource assessment estimated that 8.5 Tcf of natural gas resources are economically recoverable in the Planning Area at a benchmark price of $4.27 per Mcf (equivalent to a $30 oil price; Table 4-34). This analysis was based on assumptions that a transportation system (pipeline) would be constructed and have a delivery tariff to the Midwest states of $2.50 per Mcf. Economic gas resources are not listed at a price of $2.85 per Mcf (equivalent to a $20 oil price) because the minimum required market price for new gas fields in the National Petroleum Reserve – Alaska is approximately $3.00 per Mcf. However, as mentioned earlier, commercial gas production would not occur until there is a transportation system to move North Slope gas to outside markets.

If gas field development occurs in the future, as with crude oil, the magnitude of production would be dependent on price. In Table 4-34, the gas resources for different gas prices and project alternatives are shown. For the $2.85/Mcf case, no commercial gas production would occur whether or not a gas pipeline to the North Slope was present. Any associated gas produced with the oil would be re-injected. At $3.56/Mcf, commercial gas production would occur, and it is expected that the gas produced at that price would be associated gas (gas produced in association with the oil) produced from oil fields in the northern part of the Planning Area. The higher gas price of $4.27/Mcf would support development of stand-alone gas fields. It is expected that commercially viable gas accumulations would most likely occur in the southern portion of the Planning Area where the hydrocarbon systems are more gas-prone. Whether a hydrocarbon accumulation is classified as an oil or gas field depends upon the gas to oil ratio (GOR) in the hydrocarbon fluids. An accumulation is considered a gas accumulation if the GOR is greater than 20,000 cubic feet per barrel (USGS 1995). A gas accumulation could have varying amounts of hydrocarbon liquids (crude oil, gas condensates, and natural gas liquids).

If associated gas is commercially produced, it would be separated from the oil and produced water at field processing facilities and would be placed into gas transportation pipelines. In contrast to oil pipelines constructed on the North Slope, gas pipelines would be buried for most of their length. River crossings would be accomplished through the same methods as for oil pipelines. The optimum temperature for gas pipelines is below 32°F (0°C). Gas would have to be dehydrated, compressed, and cooled before entering the pipeline. Construction of a gas pipeline would utilize ice roads for heavy equipment, and the major disturbance that would result is the excavated trench. The permafrost would not thaw because of the temperature of the pipeline. It is expected that pipelines that transport associated gas would utilize the same corridors used for crude oil transportation pipelines. Depending on the throughput and other factors of pipeline design, stations for compressing and cooling the gas would be built at regular intervals (60 to 100 miles) along the pipeline to maintain optimum operating conditions. The footprint of the compressor station would consist of a 10 to 20-acre pad, depending on the design of the facilities. It is possible that compressor stations would also be connected to pipelines from other fields or satellites.

For stand-alone gas field development, the impacts of field development would be similar to development of an oil field (Table 4-3); the major difference would be in certain kinds of processing equipment. Field gathering lines would not have to be buried, and would be placed aboveground the same as oil field gathering lines. A gas pipeline would have to be constructed to move gas to existing infrastructure east of the Planning Area or by separate pipeline to the major North Slope transportation pipeline, the terminus of which would be located at Prudhoe Bay. In areas of existing infrastructure, the pipelines would utilize existing pipeline corridors where possible. In addition, an oil transportation pipeline could be associated with the gas pipeline if economics were to justify the production of crude oil. Commercial production of natural gas liquids might not be feasible because of lack of infrastructure to handle those commodities.

Gas Transmission Line Proposals

Efforts to permit and build a pipeline for the transportation of natural gas from the North Slope to various markets have been ongoing since at least 1973. Preliminary plans to construct transportation systems (generally pipelines) have been repeatedly offered, but have yet to secure all of the required permits, agreements with gas producers, financial backing, or marketing commitments. All project proposals to date have failed to overcome high construction costs (estimated between $10 and $20 billion) and marketing hurdles, so the proven gas resources (estimated at 35 Tcf) and undiscovered/potential gas resources (estimated at 100 Tcf) remain stranded on the North Slope.

In 1976, at least three separate projects were proposed, and EISs were prepared for each one. One project, the Alaska Natural Gas Transportation System (ANGTS), was designed to transport natural gas from Prudhoe Bay south along TAPS to the Fairbanks area, and then westward along the Alcan Highway to Caroline, Alberta, where the pipeline would then fork, with one fork taking gas to the U.S. West Coast and the other proceeding to the U.S. Midwest. Another proposed pipeline project would have transported natural gas from Prudhoe Bay eastward to the McKenzie Delta and south along the river, eventually reaching the U.S. West and Midwest. The third proposed pipeline project would have transported the natural gas in a new pipeline along TAPS to the Prince William Sound area, where the gas would be liquefied and transported as liquid natural gas (LNG) to markets via tankers. The federal government, foreseeing a petroleum energy shortage, passed federal legislation that would have expedited the permitting of the pipeline and entered into treaties with Canada. The U.S. and Canadian governments selected the ANGTS project from the three proposals, and though ANGTS was largely designed and permitted, it was never constructed for various business reasons. The proponents have maintained most of the required permits and ROWs for this project.

Alaska natural gas was revisited in the 1980s, when yet another pipeline project was proposed. The Trans-Alaska Gas System (TAGS) would have brought gas along a new pipeline in the TAPS corridor south to Valdez, where it would be liquefied and shipped overseas as LNG. AN EIS was completed and several authorizations and ROWs were obtained, but the project was never constructed.

In 2000, the major North Slope producers (ExxonMobil, ConocoPhillips, and BP) reportedly spent over $100 million conducting studies along potential routes in Alaska and Canada to determine the feasibility of constructing a gas pipeline between the North Slope and the U.S. Midwest. They concluded that the project was not economically viable at that time and that a number of issues needed to be resolved to allow the project to move forward. These issues included higher and more stable gas prices, technology advancements, and numerous federal and state government regulatory approvals that would provide regulatory streamlining and fiscal certainty. The State of Alaska has also passed a Stranded Gas Act that allows the state to negotiate with project proponents in a fashion that would also provide some of these measures.

In January 2004, a consortium of companies filed a formal proposal to the Alaska Department of Revenue under the Stranded Gas Act to build a natural gas pipeline from the North Slope into Canada that would ultimately be used to ship natural gas into the lower 48 states (Yahoo! 2004). The proposed 745-mile pipeline route would go from the North Slope southward to the Alaska-Yukon border at Beaver Creek. The application was subsequently withdrawn; however, a number of other groups have submitted applications or indicated that they will soon file applications. The North Slope producers (ExxonMobil, ConocoPhillips, and BP) have also filed an application under the Stranded Gas Act for a gas pipeline to the Lower 48 states. The Alaska Natural Gas Authority was created by a statewide ballot measure, with the stated purpose of developing a gas pipeline from the North Slope to Valdez where the gas would be liquefied and transported as LNG. The Alaska Natural Gas Authority has submitted an application for their project under the Stranded Gas Act. An Alaska Gasoline Port Authority, consisting of the City of Valdez and the Fairbanks North Star Borough, has filed an application for a similar pipeline to transport North Slope natural gas to Valdez for liquefaction and sale. Several large pipeline companies have also entered into agreements with the state indicating they will be submitting applications for various pipeline projects to get North Slope natural gas to market.

It should be noted that none of the aforementioned project proponents have submitted applications for environmental permits or ROWs; all applications to date have been filed under the Stranded Gas Act and relate only to fiscal negotiations with the State of Alaska. Because there are abundant gas reserves on the North Slope, it is likely that some exploration targeting new undiscovered gas resources in areas remote from existing infrastructure may occur during the life of this plan. However, the development scenarios do not include the production of natural gas for sale outside of the Planning Area. Until a major transportation system is constructed, future gas discoveries will be shut-in (startup delayed for an undetermined period). Associated gas recovered as a byproduct of oil production would be used as fuel for facilities or reinjected into reservoirs to increase oil recovery. The reinjected gas would not be lost as a potential future resource, but gas sales to outside markets would be postponed for the foreseeable future.

A new gas-processing technology, termed “gas-to-liquid” (GTL), can be used to convert natural gas to a refined liquid product that could be transported through TAPS. This strategy could accelerate natural gas production on the North Slope, including stranded gas fields in the National Petroleum Reserve – Alaska. However, this new technology is untested for large-scale operations and is, at the present time, a more expensive proposition than constructing a large-diameter gas pipeline. In the future, GTL technology could be used to produce gas from small, remote fields in the Planning Area.

Table 4-34. Gas Resource Estimates for Each Alternative.

Alternative	Low Price Scenario		Medium Price Scenario		High Price Scenario	
	Tcf ($2.85/Mcf)	Number of Fields	Tcf ($3.56/Mcf)[1]	Number of Fields[2]	Tcf ($4.27/Mcf)[1]	Number of Fields[2]
A	0[3]	1	NA	NA	NA	3
B	0[3]	2	3.318	10	5.274	14
C	0[3]	2	3.926	12	6.113	17
D	0[3]	1	2.702	8	4.575	12
FEP[4]	0[3]	3	6.076	19	8.509	24

[1] Two-thirds of the economic gas resource is associated with oil and one-third of the gas resource is in non-associated pools.
[2] Number of fields includes large CPF fields with production facilities and small satellites that share those facilities. Both oil and gas fields are included in this total.
[3] Gas production for outside sale is not economic at this price (see Figure APP-05; USDOI BLM MMS 2003).
[4] FEP (Full Economic Potential) represents the total undiscovered, potentially commercial, petroleum endowment assessed in the Planning Area. The FEP development scenario is not analyzed here and is shown for comparison purposes only.
NA = Not analyzed. The 1998 Northeast IAP/EIS did not analyze a $25 per bbl scenario or the sale of natural gas.

Because the export of known gas resources is uneconomical today, it is difficult to predict the viability, timing, or scale of future gas production projects. If a gas transportation system were constructed in the future, current gas reserves associated with existing oil production would be used before the industry was likely to invest in new gas exploration. The development of remote, undiscovered, and more expensive gas resources is considered to be unlikely as long as there are adequate supplies of known, readily available reserves. Thus, the cumulative impacts of future natural gas development are not analyzed in this amendment.

4.7.3.5 Oil Production on the North Slope of Alaska

Production Through 2003

From 1977 to the end of 2003, North Slope developments produced 14.4 Bbbl of oil and natural gas liquids (AOGCC 2004). Production on the North Slope peaked in 1988 at 2.0 MMbbl of oil per day, declining to its current rate of approximately 0.99 MMbbl per day (ADR 2004b). Of the producing fields on the North Slope, the most productive (in order of decreasing productivity) are Prudhoe Bay, Kuparuk River, Point McIntyre, and Endicott.

Resource Estimates Used for this Cumulative Effects Analysis

A range of reserve and resource estimates shown in Tables 4-35 and 4-36 were used for analyzing cumulative effects from production onshore of the North Slope and in the Beaufort Sea. These estimates consisted of a low range of 7.37 Bbbl, a mid-range of 12.6 Bbbl, and a high range of 18.77 Bbbl.

The Low Range - Past and Present Production

The low end of the range of oil production for the cumulative analysis takes into consideration past and present production. This production includes reserves (7.04 Bbbl) in currently producing fields and resources (0.33 Bbbl) in discoveries in the planning or development stage (Table 4-35).

The Mid-Range - Past, Present, and Reasonably Foreseeable Future Production

The mid-range of oil production for the cumulative analysis is based on past, present, and reasonably foreseeable future production. This amount of 12.6 Bbbl is composed of the 7.37 Bbbl from the low range added to discoveries that may be developed in the next 20 years. Reasonably foreseeable future production (5.23 Bbbl) consists of: 1) discoveries totaling 1.57 Bbbl onshore and offshore (Western-Central-Eastern Groups; and 2) undiscovered onshore resources of 3.66 Bbbl from the category of Undiscovered Onshore Resources shown (Table 4-36.) The Planning Area represents about 8 percent of the volume of this mid-range figure.

The High Range - Past, Present, Reasonably Foreseeable Future, and Speculative Production

The high range of production for the cumulative analysis is 18.77 Bbbl, which includes existing, planned, possible, and speculative production. The number is derived from the 12.6 Bbbl from the mid-range figure, added to speculative future production of 6.17 Bbbl and includes onshore and offshore resources as described in Table 4-36. The Planning Area represents about 11 percent of the volume of the total of past, present, reasonably foreseeable future, and speculative production. As discussed earlier, the Amended IAP/EIS is not analyzing the effects of speculative production.

4.7.3.6 State Lease Sales Considered in This Cumulative Effects Analysis

Since December 1959, the State of Alaska has held 50 oil and gas lease sales involving North Slope and Beaufort Sea leases. More than 9.8 million acres have been leased; some areas have been leased more than once because some leases expired or were relinquished. Historically, less than half of the tracts offered in state oil and gas lease sales have been leased. Of the leased tracts, about 10 percent have actually been drilled, and about 5 percent have been developed commercially (Map 3-3). About 88 percent of the leased areas are onshore or nearshore, and about 12 percent are offshore. From the early 1960s through 2003, 402 exploration wells were drilled in State of Alaska onshore and offshore areas (S. McMains, AOGCC, pers. comm). During this period, the number of exploration wells drilled annually has ranged from two to 35. During the 1960s, 58 wells were drilled, 97 wells were drilled in the 1970s, and 105 wells were drilled in the 1980s. From 1990 through 2003, 142 wells were drilled and the number of exploration wells drilled annually averaged 10. Fifty-three of the exploration wells have resulted in discoveries, a success ratio of about 13 percent.

The State of Alaska develops and approves an oil and gas-leasing plan for a 5-year period, reassesses the plan, and publishes a schedule every year. Except for Northstar, all of the North Slope and Beaufort Sea's commercially producible crude oil is on 1,212 active state leases (as of December 2003) broken down as follows: 1.35 million acres onshore along the Slope; 498,000 acres offshore in the Beaufort Sea; and 456,000 acres of active leases that straddle onshore and offshore acreage. Production through 2003 from state leases (with a small recent contribution from federal leases at Northstar) totals 13.97 Bbbl. The latest state lease sales—North Slope Areawide and Beaufort Sea Areawide—were held in October 2004 (Petroleum News Alaska 2004c). Between the end of 2004 and 2008, the State of Alaska is expected to hold the following annual areawide lease sales annually:

- Beaufort Sea Areawide sale including unleased state (within 3 miles of coastline) waterbottoms from Barrow to the Canadian border each October;
- North Slope Areawide sale, including unleased state lands between the Arctic National Wildlife Refuge and the National Petroleum Reserve – Alaska each October; and
- North Slope Foothills Areawide sale, extending into the foothills of the Brooks Range each May.

The state has not yet estimated oil and gas resources involved in these future lease sales, but informal industry estimates project 4 Bbbl in undiscovered resources on state lands on the North Slope, which include both leased and unleased state properties. Most are expected to be producible only as satellites.

The State of Alaska is continuing efforts to drill a stratigraphic test well offshore of Arctic National Wildlife Refuge. The state also recently developed a new mitigation measure (Mitigation Measure 18) to ensure that exploration, development, and production activities are conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence whale hunting. The lessee has to consult with the NSB and Alaska Eskimo Whaling Commission to discuss how siting, timing, and methods of proposed operations can be planned and carried out to avoid potential conflicts with subsistence whale hunting (Petroleum News Alaska 2004c, d).

4.7.3.7 Federal Lease Sales Considered in This Cumulative Effects Analysis

In this analysis, lease sales for the federal OCS and the National Petroleum Reserve – Alaska are considered. Although Northstar production from the federal OCS is small (1,131,639 bbl to May 2002), possible future production from Sale 186 is estimated at 460 MMbbl. As indicated above, speculative future onshore and offshore production of 6.17 Bbbl of currently undiscovered resources is also estimated (Table 4-36).

Since December 1979, the USDOI has held eight lease sales in federal waters of the Beaufort Sea. The latest, Sale 186, was held in September 2003. The Beaufort Sea Sale 195 is scheduled for March 2005; another sale is scheduled for March 2007. Over 720 leases have been issued in the Beaufort Sea, totaling 3.7 million acres. About 30 wells have been drilled on federal leases, with 9 wells determined to be producible. All wells have been plugged and abandoned, because field economics have not favored production. There are 64 active leases on federal submerged lands in the Beaufort Sea. The Kuvlum and Hammerhead units are potentially producible, although not currently leased, but there are no estimates of available resources. The Northstar Unit comprises two federal tracts. These tracts contain less than 20 percent of Northstar's estimated 158 MMbbl of oil reserves.

Table 4-35. Summary of Reserve and Resource Estimates Used in the Cumulative Analysis.

Production Activity	Oil (Bbbl)	Contribution to Total North Slope Resources by Volume of Oil (%)
Low End of the Range (Past and Present)	7.37	0
Middle Portion (Past, Present, and Reasonably Foreseeable)	12.60	8
High End (Past, Present, Reasonably Foreseeable, and Speculative)	18.77	11
Sources: USDOI BLM and MMS (2003), USDOI MMS (2003c), and AOGCC (2004).		

Table 4-36. Production, Reserves, and Resource Estimates Used in the Cumulative Analysis[1].

Timeframes and Field or Area	Oil (Bbbl)[1]	Gas (Bcf)[1]
Past and Present (total)	**7.37**	33[2]
Onshore–past	6.69	33[2]
Offshore–past	0.35	
Onshore–present	0.33	
Reasonably Foreseeable Future (total)	**5.23**	0.75[3]
Discovered Onshore and Offshore	1.57	
Undiscovered Onshore	3.66[4]	
Speculative (total)	**6.17**	32,800[5]
Onshore	3.66[6]	
Offshore	2.51[7]	
Total	**18.77**	**32,834**

[1] Production and reserve data are as of December 2003.
[2] Gas production to date is from Barrow gas fields supplied for local use to the Barrow community.
[3] All gas production from existing oil fields is used by facilities for fuel or reinjected for reservoir pressure maintenance. No gas production is transported and marketed outside the North Slope.
[4] Includes one-half of the resource of 2.054 Bbbls from Northeast National Petroleum Reserve - Alaska (this amendment) and one-half of the resource of 1.260 Bbbls from Northwest National Petroleum Reserve - Alaska at $30 per bbl. Also includes 2.0 Bbbls from unnamed satellite fields.
[5] Future production of natural gas assumes that a transportation system will eventually be constructed to move North Slope gas resources to outside markets. All proposed systems are uneconomic under current conditions.
[6] Includes one-half of the resource of 2.054 Bbbls from Northeast National Petroleum Reserve - Alaska (this amendment) and one-half of the resource of 1.260 Bbbls from Northwest National Petroleum Reserve – Alaska at $30 per bbl. Also includes 2.0 Bbbls from unnamed satellite fields. No economic resource estimates for BLM defined plays were available for the Southern Planning Area of National Petroleum Reserve – Alaska.
[7] The midpoint of the $20 to $30 per bbl estimates for the 2000 Beaufort Sea Assessment.
Sources: USDOI BLM and MMS (2003), USDOI MMS (2003c), and AOGCC (2004).

From an historical standpoint, only about one-third of the federal sales originally scheduled in the Beaufort Sea were held, and only a small fraction of the tracts offered in the sales were leased (less than 7 percent). Few of those leases were actually tested by drilling (30 wells on 20 prospects). Most discoveries (11 wells determined to be producible) were too small or too costly to become viable fields. One field (Northstar, discovered in 1984) started production in 2001, while another (Liberty, discovered in 1982) is being considered for development.

The BLM held lease sales in the Planning Area in the early 1980s. Recent lease sales by the BLM include leasing 133 tracts in 1999, and leasing an additional 60 tracts in 2002. ConocoPhillips has drilled 13 wells, with announced discoveries of gas, oil, and condensate in five or six wells. British Petroleum has drilled two wells, and Anadarko has drilled one well, but neither company has made any announcements regarding the producibility of these wells.

The BLM held an oil and gas lease sale on June 2, 2004, for 484 tracts in the Northwest National Petroleum Reserve – Alaska, and for 22 tracts that combine lands from the Northwest and Northeast National Petroleum Reserve – Alaska along the Ikpikpuk River that had not been offered previously. About 5.8 million acres were offered. Five companies submitted bonus bids totaling $53,904,491 to win rights to develop 123 oil and gas lease tracts. The single largest bid was $13,745,000 for tract D-19 near the Ikpikpuk River. The BLM may also hold lease sales in the Planning Area in 2005, depending upon the outcome of the Amended IAP/EIS.

4.7.3.8 Infrastructure and Transportation

Production of any North Slope petroleum reserves would not occur without a means of exporting the production to market. The transportation infrastructure system for any project includes four components: pipelines from the production pads to a CPF, pipeline from the CPF to TAPS, TAPS from Prudhoe Bay to Valdez, and seagoing tankers that travel from Valdez to ports on the west coast of the U.S. and in Asia.

Given the decline of production in existing Prudhoe Bay fields, the existing oil transportation system (including TAPS) is expected to be able to transport oil produced by development of new reserves on the North Slope, as well as additional enhanced recovery from the Prudhoe Bay fields during the cumulative analysis period. New fields would use infrastructure at the edge of the core area to transport processed crude oil to the TAPS pipeline. This existing infrastructure at the edge of the core area includes the Western Group (including existing Alpine, Kuparuk, and Milne Point infrastructure), which would accommodate new production from the National Petroleum Reserve – Alaska; the Central Group (including Northstar and other fields near the Beaufort coastline); and the Eastern Group (including numerous discoveries in the Point Thomson area and adjacent offshore; see Map 3-3).

Currently, the TAPS terminal at Valdez handles about 1 MMbbl of crude daily. At peak production, the Northeast National Petroleum Reserve – Alaska would produce from 14 to 77 MMbbl of crude oil annually under the final Preferred Alternative (Table 4-5). The daily production rate of 148,000 barrels per day (54 MMbbl annually for the $25 price case under the final Preferred Alternative) from the Planning Area would be approximately 15 percent of the current throughput of TAPS, and 7 percent of the peak throughput of TAPS. Estimating future production on the North Slope (including offshore) at the high end of projections, oil tankers still could be moving this daily amount of oil (about 1.0 MMbbl) from Valdez in 2009.

The cumulative impacts of operating the TAPS transportation system were evaluated in the recent Final EIS for Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way (USDOI BLM 2002). These impacts included consideration of continuing use of the crude oil transportation system to transport current and future production. It also considered the probability and consequence of spills from various elements of the system. The conclusions about the cumulative impacts associated with transportation of crude oil from the North Slope presented in the TAPS Renewal FEIS are equally applicable to this amendment, and are incorporated into this cumulative analysis. A copy of the TAPS Renewal EIS can be reviewed on-line at http://tapseis.anl.gov/; the findings are summarized below.

The TAPS Renewal FEIS made the following conclusions on impacts from continued operation of the pipeline and tanker transportation system:

- Paleontology, Air Quality, Transportation, Waste Management, Terrestrial Vegetation and Wetlands, and Cultural Resources – TAPS would have no or a very minor impact.
- Soils and Permafrost – Increased throughput could expand thaw bulbs and ground settlement near TAPS. Reduction in throughput could cause frost heaves. Overall, TAPS would be a minor contributor to cumulative effects related to soils and permafrost.
- Sand, Gravel, and Quarry Resources – The TAPS would be a minor contributor to requirements for these resources.
- Surface Water Resources – Impacts to surface waters would be localized unless an oil spill occurred, in which case impacts could be substantial. The TAPS operation would have a very small effect on surface water quality.
- Groundwater – An oil spill from TAPS or oil development activities could impact groundwater quality to a small or large extent, depending on the spill's size, and location, and the effectiveness of response activities.
- Physical Marine Environment – The marine environment could be affected by spills from tanker and other forms of marine transportation in Prince William Sound or along Pacific transportation routes. Reasonably foreseeable spills would be small, rapidly cleaned up, and of local consequence. Larger, less probable spills could take longer to clean up and result in widespread contamination of the marine environment.
- Noise – All activities would have the potential to produce local impacts on noise.
- Human Health and Safety – No substantial health impacts would be expected from the inhalation of industrial air emissions in the Valdez area. The Valdez Marine Terminal operations contribute to, but are not the sole source of, organic air pollution emissions in the Valdez area. The general public would be exposed to more

vehicle emissions over the next 30 years unless additional controls were placed on such emissions. Accidental releases of hazardous materials and spills into the marine environmental also could have small impacts on public health.

- Fish – Risks of large spills with large consequences would be minor; however, a major spill into a waterway could be severe and possibly long term.
- Birds and Terrestrial Mammals – Impacts from many activities could be large in local areas but would be minor on the population level.
- Threatened, Endangered, and Protected Species – Impacts are anticipated to be negligible to minor and are not anticipated to threaten population viability, unless a low-probability, high-volume spill from oil transportation occurred in Prince William Sound or along Pacific transportation routes. Such a spill might cause impacts that would be high on a local level.
- Subsistence – There would be minor impacts on subsistence, except on the North Slope where impacts would be moderate. Contributions from TAPS to these cumulative impacts are expected to be relatively small.
- Sociocultural Systems – In sociocultural systems founded on cooperation and subsistence, cumulative impacts might accompany their continued interaction with modern American society and the continued growth in the importance of a cash economy. However, these changes occurring throughout Alaska are not attributable solely to cumulative actions considered in the EIS. The contribution of TAPS to these cumulative impacts would be relatively small.
- Land Use and Coastal Zone Management – The contribution of the TAPS operation to these cumulative impacts is expected to be relatively small. However, an oil spill to marine waters from marine transportation or from oil production could impact implementation of Coastal Management Plans.
- Recreation, Wilderness, and Aesthetics – Oil or gas spills associated with TAPS operations could impact recreation, aesthetic, and wilderness values. Because spills could result in long-term impacts, aesthetic impacts along TAPS could be major.
- Economics – Continued production of North Slope petroleum reserves, including transportation, would make a substantial, though declining contribution to domestic oil production and would continue to reduce the need for foreign oil imports, thus improving national energy security and the overall balance of trade. Substantial federal tax revenue would be generated with continued TAPS operation, together with marine and shipbuilding employment and employment in the economy as a whole.

Tanker Traffic and Routes

On November 28, 1995, President Clinton signed legislation (30 USC 185[s]) that authorizes the overseas export of crude oil from Alaska’s North Slope in U.S. flag tankers, unless the President finds exports are not in the national interest. Tankers traveling to the Far East could carry up to 1.8 MMbbl each; however, such estimates are highly speculative because they depend on opportunities for short-term contracts. The route to the Far East would bring the tankers more than 200 miles offshore of the Aleutian Islands, a distance that should protect the biological resources of the Aleutian Chain from pollution. This traffic is in addition to current LNG shipments from an LNG plant at Nikiski, Alaska. Every 10 days, the Nikiski plant loads a tanker with 80,000 cubic meters of LNG for Tokyo, which it has been doing since 1968 without a major incident. Because LNG boils off and disperses quickly when exposed to normal air temperatures and winds in the North Pacific, it is not a major environmental threat along the tanker route.

Transportation for “Roadless” Development

The 1998 Northeast IAP/EIS prohibited permanent roads connecting the Planning Area to outside infrastructure. Lease Stipulation 48 for Northeast IAP/EIS ROD states, “Permanent roads (i.e. gravel, sand) connecting to a road system or docks outside the Planning Area are prohibited, and no exceptions may be granted” (USDOI BLM and MMS 1998). Planned oil development projects grouped around the Alpine oil field are not expected to have permanent gravel roads connecting to the Kuparuk River Unit road system. Transportation to these fields would use aircraft and marine vessels in summer; in winter, ice roads also allow the use of vehicles. As discussed below, however, the Army Corps of Engineers is preparing to assess the impacts of a proposal from the State of Alaska that would build an all-season gravel road between the Spine Road of the Kuparuk River Unit to Nuiqsut.

Colville River Road from Kuparuk River Unit to Northeast National Petroleum Reserve – Alaska

The State of Alaska's Industrial Roads Program, also known as "Roads to Resources," began in March 2003 as part of the Northwest Alaska Transportation Plan, after transportation analyses showed that new North Slope oil field roads would accelerate development and provide important revenue/employment opportunities.

As part of the Industrial Roads program, the Alaska Department of Transportation and Public Facilities (ADOTPF) is planning to construct an all-season gravel road to the eastern edge of the Planning Area. The ADOTPF has been studying several routes. The primary candidate is an 18-mile route that would exit the Spine Road at the western terminus (near the Tarn development) of the Kuparuk field road system and proceed westward to a new bridge crossing of the Colville River 3 miles south of Nuiqsut. The route would require the construction of a 3,300-foot bridge across the Colville River. The road would be 32 feet wide built on a 5-foot thick base of gravel. As reported in *Petroleum News*, the road would be capable of handling all ordinary industrial loads, including drilling rigs (Nelson 2003).

Public access to the proposed road has not been determined. At present, oil and gas producers have concerns about security. Section 118(e) of the Transportation Enhancement Act – 21 (TEA-21) authorizes the expenditure of federal funds for resource development road construction projects without regard to the traditional "public funds equals public access" caveat. The TEA-21 allows industrial use designation of these roads that precludes or limits public access, even though state or federal funds are used. The ADOTPF is investigating the full implications of this statute on the North Slope roads development program currently underway. It is as yet unclear whether the proposed North Slope road would be open to public use.

The proposed road is expected to stimulate oil and gas development on state lands and in the National Petroleum Reserve – Alaska, and provide cheaper transportation of materials and supplies to Nuiqsut. The road and bridge would enable oil and gas companies to develop staging areas on the west side of the Colville River and access points beyond via ice roads. The ADOTPF has also indicated that it is in the initial planning stages for a mainline road from the proposed Colville River bridge into the National Petroleum Reserve (Nelson 2003), but a route has not been developed.

A permit application for this route has been submitted to the USACE by ADOTPF and an EIS was to have been prepared during 2005. In late 2004, however, the State of Alaska put the project on hold pending review of other potential route options between the Dalton Highway and the Planning Area.

4.7.4 Advances in Technology

When exploration of the North Slope began, knowledge about of the effects of exploration and construction techniques on permafrost was limited. From early exploration through the 1950s, trails often were cut directly into frozen ground. Large tractors and tracked vehicles traveled over thawed ground in the summer, often leaving deep ruts, and sometimes road builders removed the vegetation mat completely, causing deep thermokarst (Bliss and Wein 1972, Hemandez 1973, Chapin and Chapin 1980). Trails commonly became wetter than the natural habitat and were colonized by species more adapted to wet sites. Higher biomass and changes in nutrient concentrations occurred in the trails (Chapin and Shaver 1981). At times, subsidence and erosion created trails as deep as 16 feet (Lawson et al. 1978). Some old trails and seismic surveys made by government contractors in the 1940s are still clearly visible because they are deeply rutted, often flooded, and filled with vegetation that is quite different from the surrounding tundra (Hok 1969, 1971; Lawson et al. 1978).

In the 1960s, peat roads were built by scooping the active layer from two sides of an area and piling it in the center to form an elevated surface. This method also resulted in severe thermokarst. By the 1970s, gravel had replaced peat in road construction. Now in many cases, ice is used.

Over the past 2 decades, new technologies have been developed and applied to exploration, development, and production on the North Slope. Some technologies, such as the use of ice roads and ice pads for exploration wells and the Arctic Drilling Platform, are unique to the Arctic and were largely developed in Alaska. Other advances, such as the use of coiled tubing, 3-D seismic-data acquisition, horizontal and multilateral drilling, measurement while drilling, low ground-pressure vehicles (Rolligons), and remote sensing, were developed elsewhere and adapted for use on the North Slope. Although some of those newer technologies have been used extensively, and the newer fields (such as the one at the Alpine field) use them almost exclusively, older technologies are still integral parts of the older portions of the Prudhoe Bay and Kuparuk fields. An understanding of the development and use of newer technologies is important in understanding what effects to resources accumulate on the North Slope, and the likelihood and magnitude of these effects in the future.

4.7.4.1 Seismic/Off-road Travel/Exploration

The new exploration-related technologies reduced the overall use of gravel and presently eliminated it from the exploration-drilling process, provided data for better siting of facilities, and reduced the number of wells required to find and evaluate a new field. Although the physical effects have been greatly reduced by the use of these technologies, there are still valid concerns regarding the potential for some amount of damage to the environment.

The environmental effects of the older road and pad construction techniques and seismic trails are matters of concern. In some instances, the effects have not diminished with the passage of time; in others, a natural but slow recovery is occurring. The visual impact, in some cases, will be evident for years, if not for decades.

The density of 3-D seismic activities can cause short-term visual impact. In areas where there is little snow cover or steep vegetated terrain, damage to the tundra and shrubs can be locally significant and long lasting. Long-term studies of the trails built for the closely spaced 3-D acquisitions are required to document the potential effects. Improvements in 3-D seismic-data acquisition and other exploration technologies allow geologists to identify higher quality prospects and to improve success rates by as much as 50 percent or more. In 1970, the success rate for exploration wells in the U.S. was about 17 percent. In addition to the advances in data quality and acquisition procedures, there have been important advances in the engineering of the vehicles used to move the camp equipment and to acquire the data. The major changes have been in the development of new “light-weight” rubber tracked caterpillar-type vehicles and vibrators that do less damage to the tundra and shrubs than the older vintage steel-tired vehicles. With the use of 3-D seismic-data acquisition, success rate increased to 48 percent in 1997 (USDOE 1999, Revkin 2001).

Three-D seismic technology was introduced about 25 years ago. Data, acquired in a grid-like manner with the individual lines spaced only a few hundred feet apart, are computer manipulated to create multidimensional representations of the subsurface. The result is a far better understanding of the geologic structures and continuity of the potential hydrocarbon-bearing formations. As with the older generation 2-D seismic data, onshore 3-D seismic data are acquired during winter, after freeze-up. Vibrators are used and these energy sources and the crews, camps, and other support facilities are carried on and/or are usually towed by low-impact tundra travel vehicles (Lance 2000). Most offshore 2-D and 3-D seismic data are acquired during the open water season using airguns rather than vibrators. Some offshore data, in the area of bottom-fast ice, are acquired during winter using land technology.

The older, land-based 2-D seismic technology consisted of long, intersecting seismic lines that used either dynamite or vibrators as the energy source. In the early stages of acquisition on the North Slope, much less care was taken to protect the tundra from damage during data acquisition. Damage, then as now, can result from inadequate snow cover and inappropriate equipment.

Offshore seismic data are acquired using patterns and spacing similar to those used in onshore acquisition. These data can be acquired only when the sea is relatively ice-free and boats can maintain long uninterrupted traverses. A high noise level is associated with marine acquisition, and it negatively affects marine organisms, especially whales.

Four-D visualization adds the element of time to 3-D seismic databases. A reservoir's fluid viscosity, saturation changes, temperature, and fluid movements can be analyzed by time-lapse monitoring in three dimensions (USDOE 1999). The time-lapse picture is built out of data re-recorded, compared, and plotted by computer onto the 3-D model. Additional data, such as well logs, production information, and reservoir pressures, may be integrated into the time-lapse imagery. The resulting information provides geologists and others with data that are valuable for both exploration for and management of existing resources. The exploration element comes from the greater ability to predict the best locations for exploratory drilling.

The 3-D seismic-data acquisition and 4-D visualization technologies provide a number of environmental benefits (USDOE 1999). They include more accurate exploration well-siting that reduces the number of dry holes, the number and length of ice roads, and the number of ice pads that have to be built; generation of less drilling waste and decreased volumes of materials, thereby lessening the possibility of a spill or other accident; better understanding of flow mechanics so that less water is produced relative to oil or gas; and increased ability to tailor operations to protect sensitive environments. Overall, fewer wells are required in order to evaluate and produce the reserves.

Nonetheless, considerable concern has existed regarding the effects of any seismic activity conducted either on land during winter or at sea during the open water season (Van Tuyn 2000). Land-based seismic-data acquisition with its large vehicles and numerous traverses across the tundra has left scars of the vehicle paths, some of which have been slow to heal and recover. At sea, migrating bowhead whales have been deflected by noises generated by seismic exploration and drilling.

The 3-D seismic-data acquisition programs require more closely spaced grids, a few hundred feet between lines as opposed to several thousand feet with standard 2-D seismic programs. This closer spacing has the potential to affect a greater amount of the tundra surface. These trails are often highly visible the following summer, in part because the old dead vegetation has been flattened by the vehicles and the green new vegetation can be more readily seen in sharp contrast to the undisturbed surrounding areas.

The closer spacing of the seismic traverses may also increase the risk that denning polar bears may be disturbed. This risk could be lessened by studies of bear denning sites and planning the acquisition programs accordingly.

Ice Roads and Pads

Arctic tundra is easily disturbed and slow to recover from damage. Disruption of tundra may also have a pronounced effect on permafrost and result in thawing and erosion. Historically, roads to exploration well sites were built of peat, bladed bedrock, or gravel, causing long-term damage to tundra that remains evident after 40 or more years. Drilling pads were similarly built of gravel or bulldozed bedrock in some areas of the National Petroleum Reserve – Alaska during the Navy exploration efforts in the 1940s and 1950s. Because of these factors, and potential damage from transporting equipment across the tundra either in the summer or winter, ice roads have replaced gravel roads and have become the means of access to isolated drilling locations. In a similar fashion, ice pads have become the standard for exploration drilling sites, eliminating the need for gravel to build pads and cleanup after drilling. All onshore exploration drilling is done during winter and all materials necessary for drilling a well, including the drilling rig, are moved to and from well locations on ice roads.

An ice road 6 inches thick and an average 30 to 35 feet wide, would require 1 million to 1.5 million gallons of water per mile of length (Van Tuyn 2000); ice roads on the North Slope are generally 12 to 18 inches thick. Frequently, exploration activity within a specific area requires more than one drilling season; therefore, more than one ice road may be built from the staging area(s) to the same drilling site or prospect. To avoid possible damage from multiyear usage of the same area, any subsequent ice road is offset by at least a road width from previous ones.

A 6-acre drilling pad, 12 inches thick, would require approximately 500,000 gallons of water (Van Tuyn 2000). The ice pads provide a solid, stable base from which to drill an exploration well. Upon completion and abandonment or testing of the well, the rig and all support facilities are moved off location and the pad is allowed to melt. The result is a very low impact operation, and usually the only indication of the drilling activity is the abandoned wellhead.

In special situations, specifically where drilling and evaluation are expected to require either an extended drilling season or two drilling seasons, insulated ice pads have been utilized. Although insulated ice pads have not been used in recent years on the North Slope, BP Exploration used such a system when drilling the Yukon Gold No. 1 and Sourdough No. 2 wells in the 1993-1994 drilling season (USDOE 1999). A 190- by 280-feet ice pad was built in March 1993 and covered with wind-resistant insulating pads. The pads remained in place over the summer and were removed in October. Drilling began in mid-November, 2 months ahead of conventional Arctic practice. With this advanced drilling start, the Yukon Gold well was completed, and the rig moved to the Sourdough site and the well completed, all in the same season. This would have been impossible with a conventional ice pad.

There is the potential for some level of short-term damage in areas that have either experienced low snow fall or removal of snow by high winds, thus creating substandard snow cover conditions. However, in most instances, there is little evidence of either the ice road or ice pad once the snow cover is gone.

The use of ice road and ice pad technology reduces the need for gravel during the exploration phase of oil and gas activity. Smaller volumes of gravel are mined during the history of a given field, less area is covered by gravel, and there is little recognizable damage to the tundra. The use of an insulated pad allows the drilling of more wells in a single season, reducing the need to build ice roads in two seasons to serve the same general area.

The older technologies had greater potential to seriously disrupt tundra, thaw permafrost, and mar the viewscape. These effects can persist for many years and many damaged sites have not been adequately remediated. Although the use of ice roads and pads has largely eliminated those problems, a different set of potential effects has been identified. Insulated ice pads have some degree of influence on the underlying tundra, because the area loses a growing season, but these effects have not been studied.

The construction of ice roads and pads relies on a ready and plentiful supply of water. Water is withdrawn from rivers or lakes, and existing ice is crushed or chipped and spread along the prescribed roadway or pad site. Concern has been expressed that the extraction of such large volumes of water may endanger fish and drinking water resources. Areas such as the Arctic National Wildlife Refuge have low lake densities and a reliable source for water to build ice roads/pads may not be present. At this time, there are few reliable data that address the controversy over the appropriate use levels for water in the construction of ice pads/roads.

Rolligons and the Arctic Drilling Platform

Potential problems associated with exploration drilling in areas with limited freshwater supply or shortened ice road seasons may be alleviated by the use of low ground-pressure vehicles (Rolligons) and the Arctic Drilling Platform. Rolligons can extend the drilling and off-road seasons on the North Slope. Current Rolligons put 4 to 5 pounds per square inch (psi) of footprint pressure on the tundra, only 1 psi per tire depending on the load and the tire size (Rolligon Corporation 2004, Petroleum News Alaska 2002). The vehicles have been used to move drilling rigs to remote locations on the North Slope. Their primary use would likely be to access locations that are far from current infrastructure and where the economies of the operation favor their use over the costs and the associated delays of building an ice road.

The Arctic Drilling Platform is adapted from offshore technology to use on land. The platform is light, mobile, self contained, and elevated. It can eliminate or reduce the need for ice roads or ice pads (Petroleum News Alaska

2002) and can serve as a temporary drilling facility or a long-term production facility. It is supported by steel pilings that contain coils for circulating hot or cold fluids. The elevated platform consists of interlocking aluminum components (12.5 feet by 50 feet) with reinforcing elements, and rests on a base of shallow containers that capture any deck fluids or other spillage. The components are transported by Rolligons, thus eliminating the need for ice roads, as well as ice pads. This platform is most appropriate where shallow wells are drilled.

Seismic exploration is expanding southward into the foothills of the Brooks Range. Current technology and regulations governing seismic-exploration permits and other off-road travel have reduced but not eliminated damage to the tundra. The nature and condition of permafrost in the foothills is poorly characterized, and the hilly topography increases the likelihood that vehicles would damage vegetation, especially on knolls and riverbanks, causing increased erosion, exposing bare soil, and creating thermokarst. In addition, future exploration would be carried out in a climate that is likely to continue to warm, with milder winter temperatures and shorter periods of freezing. It is hard to predict the consequences of vehicular traffic in winter on tundra under these altered conditions.

4.7.4.2 Drilling and Completion Technologies

An oil reservoir is part of a porous and permeable layer of rock in which the oil is trapped. On the North Slope, each production well is designed to produce from a subsurface area of at least 80 acres. Wells are located on gravel pads and are drilled vertically through approximately 2,000 feet of permafrost. Once through the permafrost, the bit is directed toward the desired bottom hole location. The number of wells per pad generally ranges from 16 to 40 (BP Exploration Alaska, Inc. and ARCO Alaska, Inc. 1997). The size of the pad and associated facilities is largely governed by the spacing between wells, and the number of pads is a function of the size of the area that can be drained by the wells on a pad. Historically, production wells were either straight or deviated holes and the number per pad was limited; hence, the number of pads needed to drain a specific area was high. The lateral reach of deviated holes rarely exceeded the true vertical depth (TVD) of the well. New technologies have done much to improve the lateral reach of a well and to reduce the size and number of well pads.

The technologies developed over the last 2 decades have greatly reduced the size of the footprint left when developing an oil field. Wells may be much more closely spaced, far larger areas developed from a single small pad, the mud systems are less toxic, and reserve pits have been eliminated.

Coiled Tubing

The use of coiled tubing is particularly valuable in sensitive environments such as the North Slope. Coiled tubing technology is quieter and has far less impact on a drilling site than conventional equipment (USDOE 1999). The technology dates from the 1950s, but only after rapid technological advances in the late 1980s did it come into common use. The tubing is mounted on a large reel and is a continuous flexible coil that is fed into the hole. The use of coiled tubing does not require the repeated “tripping” out of the hole to add additional pipe segments. One of the byproducts of coiled tubing drilling is a significant reduction in the volumes of drilling fluids compared with conventional drilling. Coiled tubing mud volumes are commonly less than half those required or generated by conventional drilling practices. In many wells, conventional methods are used to drill the initial hole and then coiled tubing is utilized to drill horizontal segments or multilateral completions. The coiled tubing technology is also commonly used for slim-hole drilling (i.e., a rotary borehole of 5 inches or less, or a drill hole of the smallest practical size) and reentry projects.

The use of coiled tubing technology has substantial environmental advantages over the conventional drilling technology. The primary benefits include: reduced mud volumes and drilling waste; cleaner operations, no connections to leak mud; reduced operations noise; minimized equipment footprints and easier site restoration; reduced fuel consumption and emissions; reduced risk of soil contamination due to increased well control; and better well-bore control. These advantages clearly support the use of coiled tubing whenever it is technically feasible. Many of the newer fields, such as the Alpine field, use this technology almost exclusively in conjunction with extended-reach horizontal drilling. No detrimental environmental effects are known to be associated with the introduction of coiled tubing technology to the North Slope.

Horizontal Drilling

Horizontal drilling became a reality in the 1970s due to advances in computers, steerable down-hole motor assemblies, and measurement-while-drilling tools. A horizontal well is drilled from an initially vertical well-bore at an angle between 70° and 110°. Vertical, or near vertical wells, drain oil from a single hole and have limited contact with the oil-bearing interval (usually limited to the vertical thickness of the rock unit). Horizontal wells penetrate the formation up to 5 miles or more from the vertical well bore, allowing more oil to drain into the well.

The results are a greater number of wells per pad, closer well spacing on the pad, and fewer well pads than using the old technology. Well spacing has decreased from 120 feet or more to as little as 10 to 15 feet between wells (BP Exploration Alaska, Inc., and ARCO Alaska, Inc. 1997). Pad size and radius of reach of the wells on the pad have undergone remarkable changes since the start-up of the Prudhoe Bay field in the 1970s.

The marked increase in drillable area per pad, as demonstrated at the Alpine field, is largely due to the extensive use of horizontal drilling technology. The environmental benefits include smaller footprints requiring less gravel and fewer wells to produce the same volume of hydrocarbons. These more effective drilling programs require less water and subsequently generate less drilling waste. Horizontal drilling results in smaller and fewer pads than did the older technologies, but gravel is still needed and effects on tundra and permafrost may result from gravel mining and emplacement. The closer spacing of well-bores has the potential to increase the rate at which permafrost thaw bulbs form, reducing surface stability and causing subsidence.

Multilateral Drilling

Multilateral drilling, a variant of the horizontal drilling technology, creates an interconnecting network of separate, pressure-isolated and reentry accessible horizontal or high-angle boreholes surrounding a single major borehole (USDOE 1999). Multilateral drilling is most effective in reservoirs that have isolated accumulations in multiple zones, have oil above the highest perforations, have lens shaped pay zones, are strongly directional, contain distinct sets of natural fractures, and are vertically segregated with low transmissibility.

The environmental benefits are similar to those achieved with horizontal drilling and include fewer drilling sites and smaller footprints, less drilling fluids and cuttings, and protection of sensitive habitats and wildlife. Multilateral drilling poses no additional recognized risks to the environment other than those associated with horizontal drilling.

Measurement-While-Drilling (MWD)

Conventional down-hole logging practices consist of running a variety of remote sensing tools down a borehole prior to setting the surface casing, before any intermediate casing strings, and prior to completing the well at total depth. These tools are attached on wire-lines and are lowered into the uncased hole and pulled back to the surface. The tools record specific types of data as they are withdrawn from the hole. These data are then used to evaluate the rock type, reservoir properties, hole integrity, and the other features concerning the physical environment of the well-bore. The procedure is routine, but it can be a risky because irregularities in the hole can result in stuck or even lost tools. Conventional logging can be especially risky in a highly deviated or horizontal hole where there is an increased probability that the tool, while being pulled out of the hole, may become snagged on a resistant rock projection or become buried by loose debris collapsing into the hole.

Additionally, these important data are not available to the geologist until some time after the well or interval has been drilled. This delay may vary from hours to days or even weeks. An example would be the desire to correlate the drilled section with that seen in a well some distance away, in order to predict a coring point or anticipate stray high-pressure sandstone.

Measurement-while-drilling (MWD) technology can provide data virtually as the intervals are drilled. Additionally, sensors provide directional information and other key data that facilitate more effective geosteering and trajectory control (USDOE 1999). The recording sensors and other necessary equipment are housed in the drilling assembly at the bottom of the pipe-string, just a few feet above the drill bit.

Because of its real time capability, the MWD technology can be used to avoid formation damage by alerting the rig crew of problems before they become too serious to correct; similarly there is a reduced possibility of blowouts and improved overall rig safety. This technology is also a contributing factor in the reduction of drilling waste volumes because it facilitates horizontal and multilateral drilling practices and provides better well-bore directional control. The technology also reduces the potential for loss of a tool assembly, reducing waste and shortening the duration of the drilling process.

Light Automated Drilling System (LADS)

As discussed earlier, the construction of ice roads and ice pads in remote areas requires an abundant water supply. There is legitimate concern regarding means of access in areas that lack sufficient water and/or fresh-water ice to build roads or if global climate change were to prevent the use of ice roads.

A possible solution to this problem, the Light Automated Drilling System (LADS), is in the research phase and is being considered for use on the North Slope. This potential drilling system is expected to be a light-weight drilling rig that can be easily broken down into several components and transported across tundra in winter by light impact vehicles that would not require ice roads. This system, or others like it, could be adapted to work in areas that lack sufficient water for ice roads or during mild winters when it would not be possible to build an ice road, transport a rig to a drilling location(s), and return it to the staging area.

The principle benefit of LADS would be to reduce the need for water to build ice roads. The primary drawback from the environmental perspective would be the increased risk of damage to the tundra while transporting rigs between locations in the absence of adequate snow cover. The same concerns exist as are presently expressed for seismic activity, but on a much reduced scale.

4.7.4.3 Development and Production

Production and associated operations are the longest-term activities in an oil field. The life of major oil fields on the North Slope could be expected to be on the order of 30 to 40 years, occasionally as much as 50 years. During this time pipelines, production facilities, waste disposal systems, water treatment plants, injection facilities, road systems, and other specialized units continue to operate.

Industry attempts to produce the maximum amount of oil/gas at the least cost in order to remain competitive and viable in the event of competition for funding or a low oil/gas price environment. The most cost efficient technologies are the obvious choice of the operators. It is not surprising that in the early phases of development and production some of these choices have proven to be less than optimal from an environmental perspective. The use of reserve pits for the disposal of used drilling muds, cuttings, and other waste is one such example.

Today, on the North Slope, as fields continue to be discovered, developed, and produced, there continues to be the need for new pipelines, production facilities, waste disposal wells, etc. To reduce the environmental effects of these activities, new technologies have been developed or adapted for use on the North Slope. New methods do not eliminate the need for gravel, water, and other materials, but they reduce their use and cause fewer disturbances, therefore reducing the potential negative effects associated with wastes and road and pipeline construction.

Enhanced Oil Recovery

This technology involves the injection of formation/source water, natural gas, and miscible fluids into the producing reservoir to maximize recovery of hydrocarbons. In this process, not only is more oil recovered per well, but much of the waste water associated with oil production is reintroduced into the reservoirs from which it was produced. Many problems that formerly were handled by surface or reserve pit disposal techniques are solved.

The principal environmental benefits are greater recovery of oil without a proportionately greater number of wells and their associated waste, environmentally friendly disposal of produced water, and reduction of emissions that would be associated with the flaring of excess produced gas. Few negative environmental effects are associated with Enhanced Oil Recovery. The primary concern is in regard to spills of produced water and the remote possibility that a reservoir may be over-pressured through the injection process, causes fracturing to the surface, and allows oil and other fluids to escape to the pad and/or tundra.

Waste Disposal

From the 1940s to the 1980s, most well-associated wastes were either stored in reserve pits or handled through other surface disposal means such as incineration. The reserve pits were prone to seepage and spills, and they contained undesirable metals and volatile organic compounds. These did, and still do present environmental risk, especially at old, unclosed remote exploration sites.

The reserve pit closure program was instituted in 1996. To date, 50 percent of approximately 600 reserve pit sites have been closed. Down-hole disposal of wastes by injection into subsurface disposal intervals is utilized in all present-day exploration wells and producing fields. This mode of waste disposal is an effective and non-contaminating method of removing many unwanted materials from the surface environment. The grind-and-inject project was undertaken to dispose of drilling muds and cuttings stored in reserve pits. Other wastes processed through the grind-and-inject plant includes Class II, RCRA-exempt oily wastes, and drilling muds and cuttings from ongoing drilling operations.

Annular injection is an environmentally safe method of disposing of drilling muds and cuttings, and the injection of Class I and Class II materials into discrete disposal zones has provided a mechanism for the handling of produced formation waters and other associated wastes (NRC 2003). However, a large number of unclosed reserve pits remain at remote exploration well-sites. No adequate plan is in effect to handle the possible pollution and resultant damage from poorly sealed and covered pits. The annular injection process has some potential to create or take advantage of poor casing or cement jobs and result in leakage to the surface. This has occurred on several occasions, but with no contamination of permafrost. Worries regarding subsidence and marine contamination have been expressed, but the existing evidence indicates that subsidence is not a concern and disposal units are effectively and naturally isolated from any contact with the ocean or seafloor.

Gravel Use and Roadless Construction

Gravel in the area of Alaska north of the Brooks Range has been used for a variety of construction and maintenance purposes. These historical uses include construction of the following:

- Dalton Highway/Haul Road in support of the development of the North Slope oil fields and TAPS;
- Pads for camps, exploration drilling, development and production drilling sites, and operations and maintenance facilities;
- Airports in oil field areas and in the communities of the NSB;
- Roads in oil field areas and in the communities of the NSB;
- Man-made islands for offshore exploration drilling and for development and production facilities;
- Docks and causeways; and
- Beach nourishment in several of the NSB communities.

From 1974 to 1999, more than 205 million tons of gravel was mined to meet the industrial and community construction and maintenance needs in the area that includes the Brooks Range, the area north of the Brooks Range to the Beaufort Sea coast (the North Slope), the Chukchi Sea coast north of Cape Krusenstern, and NSB communities (NRC 2003). Most of the gravel was mined from the floodplains of rivers. About 180 million tons of the gravel (88 percent of the total) was mined from 1974 to 1985. During this time, the Haul Road/Dalton Highway and pads, roads, and airfields were constructed for the facilities to develop the Prudhoe Bay, Kuparuk River, Lisburne, Milne Point, and Endicott oil fields. From 1986 to 1999, the amount of gravel mined annually in the Northern Region ranged from 0.56 to 4.5 million tons.

The portion of the oil-field network that is connected by roads stretches to 60 miles from the Endicott field in the east to the Tam oil field in the west. Most of the expansion of the road network was done before 1988, the development phase of the field, during which the rate of growth was about 24 miles per year. Since 1988, the rate of growth in the road network has been about 3 miles per year (NRC 2003).

The total gravel-covered area increased from about 20 acres in 1968 to about 9,200 acres in 2001 (Table 4-37). The rate of gravel placement declined noticeably after 1988, because the main road network and most of the pads in the Prudhoe Bay and Kuparuk oil fields had already been built. The average rate of growth was 780 acres per year before 1988 and 57 acres per year after 1988. Most of the gravel-covered areas are associated with onshore drilling and construction pads.

Offshore gravel islands support production operations. The Endicott islands are connected to each other and to the mainland by a 5 mile causeway and are situated in waters generally less than 7 feet deep (AOGA 2001). The shallowness of the Beaufort Sea in the Prudhoe Bay prevents large vessels from docking there. Three gravel causeways were constructed to facilitate docking, to provide access to artificial-gravel production islands, and to draw seawater for waterflooding.

The ADFG, Habitat and Restoration Division, developed guidelines for siting, design, operation, and reclamation of North Slope gravel pits. The area disturbed by gravel mines and fill placement is a fraction of the area north of the Brooks Range. The North Slope covers about 57 million acres, and the ACP covers about 13 million acres (Gilders and Cronin 2000). The area that would be disturbed by gravel mines and fill placement in 2030 is projected to be about 22,596 acres, or about 0.17 percent of the ACP (Table 4-37).

Table 4-37. Past, Present, and Reasonably Foreseeable Future Production and Development Total Disturbed Areas for the North Slope (in acres).

	1968	1973	1977	1983	1988	1994	2001	2010[1]	2030[2]
Gravel footprint areas	20	1,713	3,288	7,022	8,681	8,920	9,225	9,910	12,866
Other impacted areas[3]	308	1,388	1,552	1,694	1,698	1,753	1,765	1,900	2,460
Gravel mines	25	4,766	5,146	5,756	6,241	6,246	6,364	6,430	6,830
Dalton Highway	332	332	332	332	332	332	332	332	332
Proposed road from Kuparuk to Nuiqsut	0	0	0	0	0	0	0	108	108
Total disturbed area	685	8,199	10,318	14,804	16,952	17,251	17,686	18,680	22,596

[1] Includes disturbed areas associated with the Alpine Satellite Development.
[2] Assumes development projected to occur under the Alpine Satellite Development Plan full-field development and disturbed areas under the Amended IAP/EIS final Preferred Alternative.
[3] Disturbed area around gravel pad, peat roads, tractor trails, exploration roads, gravel pad removal site, etc.

Surface deposits within the National Petroleum Reserve – Alaska consist mostly of fine-grain clay, silt, and sand. Gravel is located along the slopes of the Brooks Range, the Colville River, and some scattered areas along the Arctic coast. West of the Colville River, gravel sources may become increasingly rare because of the low-relief, poorly drained character of the ACP. Meandering rivers have low energy and a low capability of transporting coarse clastic material (gravel) from higher elevations. The Brooks Range is far from the coast on the western North Slope. Consequently, suitable gravel sources would be far more difficult to locate. Because long hauls are often required to bring in gravel, gravel from existing work/drill sites is reused (Gryc 1985). This lack of gravel would be an important consideration in the development of permanent oil and gas facilities west of the Colville River. Although there are no specific proposals, there is ongoing discussion about the potential need for inter-community roads west of the Colville River. Such roads would also require large amounts of fill material (gravel and sand), since gravel roads require 60,000 cubic yards per mile.

In general, North Slope gravel usage for oil fields has been declining. Large fields (such as Prudhoe Bay and Kuparuk) that require a large number of production well pads are no longer being discovered. There also is a trend toward consolidating facilities and using technological advances that minimize the surface area disturbed (Gilders and Cronin 2000). Overall, the footprint of oil fields is getting progressively smaller because wells are closer spaced and on-pad structures are minimized. A smaller footprint equates to less gravel use.

Other developments that have reduced the amount of gravel needed to develop or maintain oil and gas production facilities have utilized the following practices:

- Use of ice pads instead of gravel for exploratory well-drilling pads (onshore and offshore in shallow waters, where appropriate);
- Use of mobile steel or concrete bottom-founded structures to drill exploratory wells in shallow waters;
- Use of ice roads instead of gravel roads for pipeline construction;
- Development of fields without a gravel road connection to the Prudhoe Bay/Deadhorse area (Badami and Alpine);
- Reduction of the spacing distance between development wells, which reduces the size of the development pads;
- Use of extended-reach drilling, which reduces the amount of gravel needed to develop new reservoirs that lie near established facilities;
- Recycling of gravel from roads, airfields, or pads that are no longer used; and
- Use of clean drill cuttings in place of gravel.

Future oil field development would be based on refined variants of the Alpine model. Pads would be small and few in number and construction would be largely a winter activity with transportation via ice roads. The use of gravel would be appreciably reduced. However, the scarcity of water in some areas, climate change, and other factors could make use of gravel roads more attractive economically and practically in some areas.

Pipeline Construction and Spill Prevention

Among the standard practices utilized in the construction of pipelines are gravel maintenance and construction roads, elevated river crossings, and block valves to reduce the likelihood and sizes of leaks and spills. Recent developments have lessened the environmental effects of pipeline construction, the hazards to the pipeline due to flooding, the probability and severity of leaks, and impediments to caribou movement. These new approaches were all used in the design and construction of the Alpine field oil pipeline (Lance 2000), which was built largely during the winter using ice roads. The lack of a gravel maintenance road removes one potential barrier to caribou movement, and reduces the volumes of gravel required for the Alpine field-like projects and the amount of tundra impacted by burial.

The Colville River pipeline crossing posed a considerable challenge. During breakup and the associated flooding, the river is almost a half-mile wide and could destroy an above ground pipeline or erode deeply enough to expose and rupture a line buried in a surface trench. ARCO Alaska, Inc., elected to use horizontal directional drilling to position the pipeline deep beneath the river channel (Lance 2000). More than 4,000 feet of pipeline were placed 100 feet below the river.

After conducting an oil-spill isolation strategy study that reviewed ways of meeting federal leak-containment regulations, ARCO Alaska, Inc., elected to use 39 to 46 feet high vertical loops on the Alpine field pipeline in lieu of the more conventional block valves. The study concluded that when used in tandem with emergency pressure-letdown valves or divert valves, vertical loops would contain drain-down-related spills as well as block valves, while offering operations and maintenance efficiencies (Pavlas et al. 2000).

The loops are better than manual block valves for reducing catastrophic failures and they provide protection levels similar to those achieved by remotely-actuated valves for leaks of all sizes. They are not potential leak sites, as valves are, but they do not provide any substantial benefit over block valves for pinhole leaks. With approval from the Department of Transportation, the loops were placed at river crossings and high points along the line.

These new pipeline construction methods greatly reduce the environmental effects on tundra, provide for a safer line, and lessen the probability of spillage due to river-induced pipeline damage. They also more effectively limit the size of catastrophic spills. However, the placement of a pipeline at depth beneath a river could make detection and cleanup of a spill in the buried segment difficult. The preexisting and predominant North Slope pipeline technology presents impediments to caribou movement when in close proximity to roads, and river crossings are sites of potential severe environmental consequences if a spill occurs. The accumulation of effects of continued construction of pipelines and road systems could increase the magnitude of displacement of the calving caribou away from the coastal strip and prime forage/insect-relief areas.

Remote Sensing

Remote-sensing techniques such as infrared photography, have been used to design and locate roads and facilities, such as development facilities and ice roads and ice pads, to reduce effects on the environment. Satellite infrared photography has been utilized to facilitate habitat mapping in the Alpine field (Lance 2000). The environmental benefits come from the avoidance of critical habitat and better design of facilities that must be placed within less than ideal locations. No negative consequences have been identified with the use of this technology.

4.7.4.4 Abandonment and Restoration

The factors leading to a decision to abandon a field can differ for each field, but declining production rates and oil price are usually the two key considerations. Abandonment occurs when the field is no longer economically viable. In the Planning Area, abandonment would not be expected to occur within the life of this plan, as no production has occurred to date, and newly discovered and developed fields are generally economically viable for at least 20 years.

To date, very little abandonment (except for single exploration or development wells) has occurred anywhere on the North Slope. According to the U.S. General Accounting Office (GAO; 2002), as of December 2001, no production pads have been abandoned, as all of the production wells associated with the pad must first be plugged and abandoned, which has not taken place. Restoration of other types of facilities, such as gravel extraction sites and older exploration pads, has taken place at a small scale at several locations on state lands on the North Slope outside of the Planning Area (Jorgenson et al 1992; McKendrick et al 1992; Herlugson et al 1996; McKendrick 1996). These restoration efforts are being closely monitored in an effort to determine the most appropriate and effective methods for restoration.

As the infrastructure ages or is abandoned, other unintended environmental effects can result. Aging increases the likelihood of failure, which can lead to accidental discharges (spills) or to other accidents. Abandoned roads and other structures can degrade from melting permafrost and continue to alter the visual environment, especially if the climate continues to warm.

Most North Slope oil-field equipment dates from the last quarter of the 20th century, and it will continue to age over the next 25 years, the period of this report’s scope. Components that could fail include pipelines through corrosion, subsurface safety valves, and safety systems to suppress fires and explosions. The older oil-field areas, such as Prudhoe Bay, will be most susceptible to aging. Thus, age-related maintenance demands will increase as oil revenues from declining oil fields decrease. As an aging field's production declines and the cost of extracting oil increases, the economic incentive to postpone or eliminate maintenance and replacement will increase. The environmental effects of aging infrastructure will depend on interactions between the economics of declining fields, increased replacement and maintenance costs, the regulatory regime, and other factors equally hard to predict.

The oil industry and many public landowners use the term "dismantlement, removal, and restoration," or DR&R, to refer to dismantlement and removal of infrastructure and restoration of the land following removal activities. The DR&R can range from complete restoration to a natural state approaching original condition to simply removing structures (GAO 2002).

The State of Alaska has adopted general DR&R requirements that contain no specific stipulations on what infrastructure must be removed or to what condition the lands must be restored once oil production ceases (GAO 2002). The state specifies that oil companies must return the land to the condition that is satisfactory to the state, a condition that has not been defined. Other entities, such as the USACE, NSB, and Native landowners, have the authority to impose DR&R requirements, but generally defer to the state to impose these requirements. Under existing funding mechanisms, only a small portion of the funds needed would be available to dismantle, remove, and restore oil and gas facilities. The State of Alaska requires companies to post bonds or other forms of financial assurance as a condition for obtaining a lease and drilling permits. However, companies are required to maintain only $500,000 in assurances to cover all of their leases in the state; it is estimated that it will cost billions of dollars to conduct DR&R for existing infrastructure on the North Slope.

The BLM's overall restoration goal for the National Petroleum Reserve – Alaska is to return it to its previous use, which includes fish and wildlife habitat, after oil production ceases; however, the BLM has yet to develop specific DR&R requirements for companies to use. On the other hand, the MMS, has specific DR&R requirements for offshore drilling. Both agencies have the authority to require full financial assurances to fund DR&R. The MMS has an escalating bond structure that considers, among other things, the future costs of reclamation, increasing the likelihood that future DR&R costs would be covered by the bond.

By the terms of federal and state leases and permits, it is the responsibility of the lessee/applicant to remove facilities and rehabilitate the land upon field abandonment or expiration of a lease or oil and gas-related permit to the satisfaction of the land management authority (Lease Stipulation 58 [No Action Alternative]; Lease Stipulation G-1 [final Preferred Alternative and alternatives B and C]). Abandonment plans would be developed at the time of abandonment or expiration of the lease or permit, in consultation with appropriate local, state, and federal agencies, and would be subject to federal (BLM, USACE and/or USEPA) and state approval. The AO would take into consideration alternative uses for the infrastructure and the impacts of removing infrastructure and alternative means to rehabilitate the land. Federal agencies would undertake appropriate NEPA analysis of any such abandonment and rehabilitation decision at the time of abandonment or expiration of a lease or permit. All costs associated with abandonment, removal, and restoration are the responsibility of the lessee.

The AO may require any range of abandonment and rehabilitation steps for roads. For gravel roads, these steps could include: 1) leaving roads in place and maintained for continued use; 2) revegetating roads either naturally or actively by the permittee, removing bridges and culverts, and breaching roads to facilitate more natural water flow; or 3) removing roads, with gravel either being placed back into gravel pits or reused for other development in the area.

Abandonment of the proposed pipelines could include demolition and removal of the facilities and restoration of disturbed ground. It is anticipated that pipeline removal would be consistent with that described for TAPS in the TAPS Right of Way (ROW) Renewal EIS. Based on TAPS, it is assumed that abandonment could include the following:

- All aboveground pipelines, valves, and supporting structures would be removed to a depth that would prevent frost heave action lifting the remnant to the surface.
- Any below-ground pipeline segments would be cleared, cleaned of oil and other residues, capped, and left in place in locations where they would not interfere with other abandonment activities or planned land uses.
- Central production facilities would be used as work camps and staging areas to support pipeline abandonment activities.
- Residual, surplus, and scrap materials would be reused or recycled to the extent possible, and waste materials would be disposed of in accordance with applicable regulations.

It is assumed that aboveground facilities would be removed and wells plugged and capped. Equipment could be retrofitted for other North Slope use, or removed from the North Slope for subsequent reuse or scrap. Just as with roads, the ultimate fate of the gravel pad would not be known until closer to end of the production pad life. Permitting agencies could require that gravel be removed, in part or total, and the tundra revegetated. If other uses are determined by the permitting agencies to be preferable, the agencies could allow the permittee to leave the gravel pads in place, either revegetated or not revegetated. Removed gravel either would be disposed of or reused for another development.

Abandonment of airstrips could occur in conjunction with abandonment of pads. The gravel airstrips would be managed in a similar manner, depending on the decisions made by land managers and permitting agencies at the time of abandonment. Gravel airstrips would either be removed and the tundra revegetated, revegetated but otherwise left in place, or left in place and maintained for public use.

As with roads, abandonment of bridges and culverts would occur once the economic life of the oil fields had passed. Because the bridges and culverts are an integral portion of the proposed road network, the fate of the bridges would likely be determined by the fate of the road network. If bridges were removed, bridge superstructures would be taken apart and transported out of the area for recycling or disposal of the materials. Bridge piles likely would be cut off below the lowest anticipated scouring elevation from either natural scouring or a flood-induced event. The area of bridge abutments would be revegetated in a manner similar to that of the roadbed after gravel removal. If roads were left in place, but not with the intention that they be maintained for continued use, culverts could be removed and the gravel pads breached to facilitate water flow.

Abandonment activities would occur during winter months, when ice roads could be constructed to allow the removal of equipment. Overall, abandonment operations would take many years, as revegetation and environmental monitoring studies would continue to document the long-term effects of operations at a particular site. Monitoring abandonment would require periodic revisits to gather information on environmental parameters related to natural bedding and to document the success of abandonment actions. Normally, one helicopter with a crew of three would visit the sites annually for the first 5 years, followed by visits with increasing time gaps over the next 10 years. Site visits would include a maximum of 1 day per visit, and 1 visit per year. A series of permitting and inspection activities would be associated with any oil field abandonment, and would involve visiting the site as needed until satisfactory revegetation occurred.

Technical and Natural Constraints to Reclamation

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

Recovery of disturbed sites on the North Slope is complicated by the fact that any disturbance of the insulating vegetative mat can melt the underlying permafrost, a process that is extremely difficult to reverse and that can continue long after the initial disturbance ends. Finally, gravel pads and roads, which account for the vast majority of the directly affected habitat on the North Slope, retain moisture and nutrients poorly and thus slow recovery processes.

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Reclamation Research

During the past few decades, considerable industry research has examined the feasibility of rehabilitating areas disturbed by oil field activities (McKendrick 1997). Until recently, work focused on revegetating sites with exotic grasses to avert erosion. More recent efforts have focused on the use of native grasses and forbs and on the restoration of habitat processes and aesthetics, all of which are much more challenging goals (AOGA 2001).

A variety of rehabilitation strategies has been developed, including flooding of gravel mine sites to create overwintering habitat for fish; creation of wetlands in ponds perched on overburden stockpiles; revegetation of thick gravel fill and overburden to compensate for lost wildlife habitat; removal of gravel fill to help restore wet tundra habitats; restoration of tundra on less severely modified habitat; and remediation of areas contaminated by oil spills, seawater spills, and drilling mud (Jorgenson and Joyce 1994). The oil industry is conducting experiments at several sites throughout the Prudhoe Bay oil field and at old well sites in the National Petroleum Reserve – Alaska. Preliminary results indicate that, if cost is not a factor, a productive and diverse vegetative cover can be established even on sites with severe ecological limitations. Most of the studies suggest that natural recolonization occurs relatively rapidly on thin fill and on organic rich fill where moisture and nutrients are not severely limiting (Jorgenson 1997). Low temperatures near the coast, however, reduce the number of species available and the rate at which recolonization occurs. A survey of 12 revegetated pads in the National Petroleum Reserve – Alaska showed that, on average, only 3 native species were found on pads at the cold coastal sites, 10 were found on inland coastal plain pads, and 24 were found on relatively warm foothills sites (McKendrick 1987). Fertilization and seeding with normative species appears to delay natural recolonization (Jorgenson 1997).

More costly methods are required for rehabilitating the gravel roads, pads, and mine sites that dominate disturbed land. Construction of berms and basins, application of topsoil, and use of various plant cultivation techniques are required on these sites. However, only a very limited amount of topsoil has been stockpiled for future use in the oilfields (Jorgenson 1997). Sewage sludge is being considered as an alternative source of organic material. Native legumes with nitrogen-fixing ability could be essential for sustaining the long-term productivity of those sites.

Removal of gravel fill has recently been done in wetlands, and preliminary studies suggest that wetland mosaics of vegetation can be restored, although the method is expensive and finding acceptable locations for the fill can be difficult.

Open-pit gravel mine rehabilitation typically involves converting mine sites to lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats.

4.7.4.5 Global Climate Change

Based on current scientific research, there is growing concern about the potential effects of primary greenhouse gases (CO_2, methane, NO_x, ozone, water vapor, and chlorofluorocarbons) on global climate. Through many complex interactions on a regional and global scale, the lower layers of the atmosphere experience a net warming effect. These trends could be caused by greenhouse warming or natural fluctuations in the climate. There is an ongoing scientific debate about the cause of these trends.

The assessment of the impacts of climate change is in its formative phase, and it is not yet possible to know with confidence the net impact of such change. The potential effects of global climate change could alter water supply, food security, sea-level fluctuations, increasing levels of ultraviolet radiation, and natural variances in the ecosystem (ACIA 2004). Global climate change may affect surface resources in the Planning Area. Arctic average temperature has increased at almost twice the rate as the rest of the world.

Possible impacts of global climate change include negative effects on the ecology of the Arctic tundra, sea ice, and changes in the permafrost depth. Reduction in sea ice as a result of global climate change would affect marine mammals (particularly polar bears), fish, and birds, with related implications for Native subsistence harvests. A reduction in sea ice would likely increase marine transport and allow increased offshore extraction of oil and gas. Species ranges are predicted to move northward. Due to loss of habitat, or from competition from other species whose ranges shift northward, some Arctic species may be pushed toward extinction. Treeline is expected to move northward, with forests replacing tundra and tundra vegetation moving into unvegetated areas. Early thawing of rivers may impact caribou migrations to calving grounds. In addition, potential sea level rise, increases in severe weather, and thawing of tundra could have negative effects on oil and gas-related infrastructure. Elevated ultraviolet radiation levels could lead to higher levels of skin cancer, cataracts, and immune system disorders in Alaska Natives. However, some Arctic fisheries are expected to become more productive.

Because climate change must be viewed from a global perspective, the magnitude of the emissions potentially contributed by oil and gas activities in the Planning Area needs to be viewed in that context. Activities associated with exploration, development, and production of oil and gas resources from the Planning Area would produce some of the listed greenhouse gases, primarily as a result of power requirements and fuel consumption, activities that produce CO. The incremental contribution of greenhouse gases from the proposed alternatives in the Planning Area would be minor when compared to total greenhouse gas contributions. Despite the fact that a relatively small percentage of the world's greenhouse gas emissions originate in the Arctic, the changes in climate in the Arctic are among the largest on earth.

The winter drilling season on the North Slope has been shortened by half because warmer temperatures result in later freezing of the tundra and earlier thaws in the spring. Although the 2003-2004 winter drilling season had the earliest opening in several years, no conclusions can be drawn as to whether it is the beginning of a trend. Based on the last 30 years, the overall trend is that the drilling season is getting shorter, in spite of an occasional earlier opening or later spring thaw. If this trend continues, the continued shortening of the drilling season would have serious impacts on the way in which oil and gas activities are conducted, with the greatest impact on exploration activities. It is possible that technological advances in transportation and drilling equipment would mitigate the effects of shorter seasons and result in an entirely new approach to drilling in the Arctic that would have much less impact on the environment. It is not possible at this time to estimate the long-term effects of the shortened seasons on the discovery of hydrocarbon resources, but if trends continue, shorter drilling seasons could have the effect of reducing the recovery of the available resource.

4.7.5 Resource Protection Measures Considered in the Cumulative Effects Analysis

The cumulative impacts assessment assumes that ROPs and lease stipulations developed for the alternatives (see Appendix E and Section 2.6.1) would be adopted to protect environmental and social resources in the Planning Area. The effectiveness of these protections has been identified under each resource area for each alternative in Sections 4.3, 4.4, 4.5, and 4.6, and in Table 2-2.

In addition, a number of federal, state, NSB, and Alaska Native resource management and monitoring programs have been established to protect environmental resources and, in cases where there is existing environmental impairment, to effect restoration. The assessment of cumulative impacts must recognize the existence of these programs and assume that the mandate under which each program was established will continue. The practical effect of these programs is that they are assumed to require avoidance or mitigation of the environmental impacts that they are designed to address. The programs assumed to continue for the cumulative impact assessment are described by the resource that they manage or protect in the following sections:

4.7.5.1 Air Quality

Air quality is regulated under the PSD permitting process. For sources located in the OCS, the PSD program is administered by the USEPA. For sources located in state waters and onshore, the PSD program is administered by the ADEC. Although minor sources of air pollutants are not subject to PSD permitting requirements, the analysis of cumulative effects to air quality in this amendment considers the contribution of both major and minor sources of air pollution on the North Slope.

4.7.5.2 Water Quality

Water quality on the North Slope is regulated and/or monitored through various permitting and regulatory programs administered by the USEPA, ADNR, ADEC, ADFG, and NSB. These programs have been established to protect against the significant degradation of water quality associated with specific human and development activities. In evaluating the cumulative effects to water quality, collective impacts associated with regulated and non-regulated activities and naturally occurring events are considered.

4.7.5.3 Wetlands and Floodplains

Wetland impacts are mitigated through lease stipulations, ROPs, permits, and approvals issued at the exploration and development stages, and under Section 404 of the Clean Water Act, administered by the USACE. The objective of mitigation for unavoidable impacts is to offset environmental losses. Under a Memorandum of Agreement between the USEPA and USACE, it is recognized that in areas such as the North Slope of Alaska, avoidance or compensatory mitigation may not be practical due to the high proportion of land that is wetlands. The USEPA and USACE are working with industry to develop alternate methods to satisfy necessary compensation requirements for loss of wetlands on the North Slope.

4.7.5.4 Essential Fish Habitat

The amended Magnuson-Stevens Act requires federal agencies that authorize, fund, or conduct activities that may harm Essential Fish Habitat to work with NOAA Fisheries Service to develop measures that minimize damage to EFH. By providing EFH conservation recommendations before an activity begins, NOAA Fisheries Service may help prevent habitat damage before it occurs, rather than restoring habitat after the fact, which is less efficient, unpredictable, and often more costly.

4.7.5.5 Caribou

The ADFG monitors caribou by a census of caribou calving and caribou distribution. These monitoring efforts provide a means of determining whether cumulative effects on caribou have occurred, or are occurring, on the North Slope, and help in developing measures to minimize effects.

4.7.5.6 Marine Mammals

The management of seals by NOAA Fisheries Service and polar bears by the USFWS under the Marine Mammal Protection Act of 1972 provides for protecting these species' populations and mitigating the potential effects of development on these species. For example, the USFWS implements measures to protect polar bear den sites through a Letter of Authorization under the Marine Mammal Protection Act.

4.7.5.7 Threatened and Endangered Species

The ESA of 1973 and the Amended IAP/EIS scoping process are appropriate vehicles to identify species that are potentially at risk from the incremental cumulative effects of activities that may occur under this amendment. Effects on listed species identified in the Planning Area by NOAA Fisheries Service and the USFWS under Section 7 of the ESA are covered by this cumulative analysis. The potential effects on each of the other species identified through scoping have also been reviewed and included, as appropriate.

Cumulative effects are analyzed for those species listed as endangered or threatened, or that are proposed or candidate for listing on the North Slope, in the Beaufort Sea, and in the Chukchi Sea, and that NOAA Fisheries Service and the USFWS indicated that this amendment should assess.

4.7.5.8 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* and an accompanying Presidential memorandum require each federal agency to make the consideration of environmental justice part of its mission. The existing demographics (race and income) and subsistence consumption of fish and game are discussed, disproportionate environmental and health effects on Alaska Natives are evaluated, and mitigating measures and their effects are presented.

4.7.5.9 Consultation and Coordination with Indian Tribal Governments

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments,* requires consultation with Native tribal governments on "actions that have substantial direct effects on one or more Indian tribes." Representatives of the BLM have met with local tribal governments to discuss subsistence issues relating to the Amended IAP/EIS (see Chapter 5, Consultation and Coordination), and have established a dialogue on environmental justice with these communities. Mitigation measures included in this amendment evolved through negotiations between local, state, and federal agency representatives. Iñupiat traditional knowledge also had a part in developing mitigation. Conflict avoidance agreements between the oil industry and Iñupiat subsistence hunters are an important mechanism for overcoming conflicts.

4.7.6 Other Information Considered in Cumulative Effects Analysis

The assessment of cumulative impacts from oil and gas activities also considered the following information:

- More rigorous environmental standards and more environmentally prudent industry practices exist than ever before, including smaller facility footprints, fewer roads, directional drilling, elimination of most surface discharges into the water, practices that avoid damage to the tundra, and better working relations with the local residents.
- Current industry practices and the environmental state of the North Slope/Beaufort Sea region are continually observed and assessed, and much of this information is available to the public. This information, along with the ongoing dialogue between all levels of government and the interested public about environmental issues should continue to increase environmental awareness and encourage environmentally sound practices that, in turn, help reduce the potential for environmental damage.
- A key element in the development of North Slope/Beaufort Sea oil is the means of transporting the oil to outside markets—TAPS. The TAPS pipeline is 800 miles long, stretching from Pump Station 1 at Prudhoe Bay to the Valdez Marine Terminal. Assuming a corridor width of about 100 feet, it represents an area of about 16 square miles. This pipeline is expected to continue to serve as infrastructure for all oil production in the foreseeable future, eliminating the need for the construction of new oil pipelines other than feeder pipelines.

- Following the Exxon Valdez oil spill, substantive improvements have been made in tanker safety to reduce the potential for oil spills from tanker accidents, such as a mandatory phase-in of double-hulled tankers, better navigational systems, and tanker escorts. In addition, oil spill response capabilities for tanker-related oil spills have been increased substantially through the addition of equipment, personnel, training, and exercises. These initiatives were developed specifically to reduce the potential for future tanker accidents and to lessen their effects, should spills occur.
- If a major oil spill were to occur, there likely would be a slowdown in new development during which additional safeguards would be put in place and new ideas of pipeline placement and design would be researched. With these safeguards in place, the likelihood of an additional oil spill occurring from the same causative factors and impacting the same resources would be reduced. This emphasis on preventing a similar incident would further ensure the full recovery of those resources from the initial spill.
- Actual activities and the size and location of future oil and gas developments on the North Slope and in the Beaufort Sea are uncertain; this amendment presents a best estimate of what those activities and effects would be. It is unlikely that actual activities and effects would exactly match the scenarios developed for this amendment. Past efforts to foresee future activities have over predicted those activities in the projected scenario. Effective corrective measures have come out of ongoing monitoring by industry, government, and environmental groups. Subsequent discoveries and developments and other changes not accounted for in this scenario may need to be reassessed, as appropriate and as required by NEPA.

4.7.7 Analysis of Cumulative Effects By Resources

4.7.7.1 Air Quality

Cumulative air quality impacts may result from the emissions of hydrocarbons and byproducts of combustion. These impacts are primarily associated with onshore and offshore industrial activity on the North Slope, and to a lesser extent with road and pad construction and use, exploration activities, and abandonment and reclamation. Air quality impacts would also result if a spill occurs and the decision is made to burn the oil to lessen the impacts of the spill. Indirect impacts from air emissions include impacts to human health and global climate change. Technology has played an important role in reducing air emissions from oil and gas facilities, and will continue to do so in the future. These impacts may be regionally additive (e.g., increased concentrations of specific pollutants) or synergistic (e.g., chemical reactions that form ozone).

Past Effects and Their Accumulation

The types and relative amounts of air pollutants generated by oil and gas operations vary according to the phase of activity. During the exploration phase, emissions are produced by 1) diesel-power-generating equipment required for drilling exploratory and delineation wells; 2) trucks and other vehicles used in support of drilling activities; and 3) intermittent operations such as mud degassing and well testing. Pollutants generated primarily consist of NO_x (although both NO and NO_2 would be generated, ambient air standards are set only for NO_2), CO, and SO_2.

During the development phase, the primary emission sources are 1) piston-driven engines or turbines used to provide power for drilling, 2) heavy construction equipment used to install modules and pipelines, and 3) various vehicles and aircraft. The principal development-phase emissions consist of NO_2 with lesser amounts of SO_2, CO, and PM.

During the production phase, the primary source of emissions are power generation for heating, oil pumping, and water injection. The emissions consist primarily of NO_2, with smaller amounts of CO and PM. Another source of air pollutants is evaporative losses of VOCs from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring also contribute to VOC and SO_2 emissions.

Ambient air quality on the North Slope of Alaska is relatively pristine, even though oil and gas exploration, development, and production have been under way for more than 30 years. Air monitoring at sites in the Kuparuk and Prudhoe Bay fields has indicated that concentrations of NO_2, SO_2, and PM_{10} are well within state and federal air quality standards. British Petroleum's air quality modeling for the Liberty Project found that emissions from the Prudhoe Bay and Kuparuk fields have very little effect on ambient concentrations elsewhere.

There is concern that air pollutants (trace and major metals) may be harmful to Arctic vegetation, even at low concentrations, but there are few studies of air pollutant impacts on tundra vegetation. Kohut et al. (1994) measured air pollutant concentrations and their effects on vegetation adjacent to the CPF, where gas powered turbine pumps compress natural gas prior to injection, in the Prudhoe Bay oil field. The CPF is the largest source of NO_x in the Prudhoe Bay oil field, producing NO_x, NO_2, and NO, as well as O_3 and SO_2. Emissions from the CPF did not have effects on the local vegetation. Results did show an increase in foliar nitrogen near the CPF, but no visible injury to plants was found. Primary productivity in Arctic tundra, however, is often limited by nutrient supply, particularly nitrogen and phosphorus (McKendrick and Mitchell 1978; Chapin et al. 1980; Chapin and Shaver 1985). Fertilization leads to higher productivity and changes in the structure of Arctic plant communities (Chapin and Shaver 1985, McKendrick 1997) and may alter carbon balance at the ecosystem level (Billings et al. 1984). These impacts are likely to be confined to the immediate area of the pollutant source, but would accumulate (USDOI USFWS 1995a, NRC 2003). The use of more efficient air emission control technologies, reinjection of gas instead of flaring, and greater reliance on ice roads instead of gravel roads that produce dust, have helped to reduce the amount of pollutants generated on the North Slope.

Arctic haze is a phenomenon resulting from elevated concentrations of fine particulate matter found over the Arctic, primarily in winter and spring. Scientists believe that most of the pollutants contributing to Arctic haze are from combustion sources in Europe and Asia, as the Arctic haze phenomenon was first observed in the 1950s, long before oil development started on the North Slope.

Summary of Past Impacts and Their Accumulation

Ambient air quality on the North Slope of Alaska is relatively pristine, even though oil and gas exploration, development, and production have been under way for more than 30 years. Trace amounts of air pollutants, including metals, are accumulating in the vegetation at very low levels. Arctic haze is a phenomenon resulting from elevated concentrations of fine particulate matter found over the Arctic, and persists today. However, industrial activities in Europe and Asia appear to be the source of pollutants that contribute to Arctic haze.

Future Effects and Their Accumulation

Emissions on the North Slope are expected to decrease as the result of an overall downward trend in oil production; therefore, any possible contribution from local sources to air quality and Arctic haze would be reduced. Greater reliance on technologies that reduce the need for permanent roads and pads, and reduce the size of the facility footprint, would also result in lower levels of PM emissions.

Potential impacts from future lease sales offshore and on land would be scattered over a rather large area. Emissions associated with routine program activities could cause small increases in concentrations of some air pollutants, although it is not expected that there would be any exceedance of national or state air quality standards.

Maximum concentrations of air quality pollutants occur within 330 to 660 feet of the facility boundary, and dissipates rapidly as distance from the facility increases. Thus, there would be very little cumulative interaction between developments addressed in this proposal and other oil-producing facilities.

Arctic haze has the potential to increase as Asian economies grow. Until air pollution concentrations in Asia and Europe begin to decline, Arctic haze is likely to persist or get worse.

Abandonment and rehabilitation activities could have impacts similar to those of construction since it is anticipated that similar vehicles and other emission sources would be used. Because abandonment would not occur at a single location for any substantial length of time, and only a small portion of infrastructure may be reclaimed, the impact of air emissions at any single location and on the North Slope would be minor and short term. Impacts would be less than those associated with construction if gravel fill was left in place, because there would be less use of the heavy vehicles and machinery that emit air emissions. During and following abandonment, production facilities would no longer contribute to North Slope air emissions, resulting in a countervailing effect to abandonment effects. Particulate matter emissions would also be reduced at sites that are revegetated.

Global Climate Change

While it is difficult to estimate greenhouse gas emissions from past and future oil and gas production activities in northern Alaska, it is assumed that greenhouse gas emissions would continue to be proportional to the oil production rate at the current ratio. Based on an assessment for the ADR (2004b), it is projected that oil production would remain near current levels (0.985 MMbbl), or decline somewhat, during the next decade. Based on this assumption, the regional greenhouse gas emissions associated with future cumulative production would be approximately the same as current emission levels, and approximately ½ the emission levels in the late 1980s. Greenhouse gas emissions associated with production activities can be reduced by using more fuel-efficient power generating equipment and vehicles and by minimizing flaring. The cumulative future oil production in northern Alaska would produce a relatively small (approximately 1 percent) additive contribution to global greenhouse gas emissions. Global greenhouse gas emissions could be reduced by conserving energy, improving energy efficiency, and developing alternative energy sources. The need for continued development of domestic new oil and gas resources will continue to exist, regardless of any downward pressure on the growth of future oil consumption as a result of measures to reduce greenhouse gas emissions. If Alaskan energy sources were not developed in the future, resources would have to be produced in other areas of the globe. The impacts on greenhouse gas emissions on the planet would be very similar, regardless of the location of the energy source.

Contribution of Amendment Alternatives to Cumulative Effects

Emissions from development resulting from the final Preferred Alternative and other alternatives would be small compared to the emissions from Prudhoe Bay and Kuparuk oil field production; projected emissions from the alternatives would account for only a small percentage of current and projected emissions.

The ADR (2004b) estimate of future oil production from the North Slope (0.84 to 0.99 MMbbl annually for the next 10 years) is similar to the current levels of production. Assuming that air pollutants generated are proportional to oil production levels, the Planning Area would contribute approximately 6 (Alternative A) to 16 (Alternative C) percent of the projected total output of air emissions on the North Slope, assuming an oil price of $25 per bbl; the final Preferred Alternative and Alternative B would be intermediate to these levels.

Conclusion

In the coming years, for the North Slope area as a whole, air quality should improve in those areas where oil production currently is the greatest, and should decline in areas where future development is expected to take place. It is likely that new development would be relatively scattered, keeping regional impacts small, except for higher, localized concentrations in the immediate vicinity of production facilities.

The cumulative effects of all projects affecting the North Slope of Alaska in the past have caused generally little deterioration in air quality, which remains better than that required by national standards. The amount of air pollutants generated should remain near current levels, and approximately 50 percent less than emission levels in the late 1980s. Improvements in air pollution control technology would help to reduce emissions from current levels, while air emissions could increase if more energy is required to maintain production in declining fields as waterflood or gas-lift injection are used to enhance oil recovery (NRC 2003). Clean Air Act standards would be used to establish the maximum concentrations of allowable pollutants for each operation proposed. As facilities are shut down, they would no longer contribute to North Slope air emissions. Particulate matter emissions would also be reduced at sites that are revegetated.

4.7.7.2 Paleontological Resources

Paleontological resources (plant and animal fossils) are nonrenewable. Once they are impacted or displaced from their natural context, the damage is irreparable and cumulative. While much of the Planning Area and North Slope is underlain by paleontological resources, most of these resources are of the marine plant and invertebrate variety and are so numerous that the potential impacts addressed in this amendment do not present a substantial threat. However, vertebrate fossils are much less common and are more likely to be impacted by the activities associated with non-oil and gas activities and oil and gas exploration and development on the North Slope.

While oil and gas exploration and development in the Planning Area are the primary contributing activities in terms of cumulative effects on paleontological resources on the North Slope, other contributing factors may also be important. These factors include permitted activities such as non-oil and gas development, overland moves, scientific data gathering, and recreation, and global climate change.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely impacted near-surface paleontological resources. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, vegetation scars persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

Paleontological research and excavation, necessary for the recovery of scientific data, have contributed to the displacement of paleontological resources. Recreational activities and past exploration of the North Slope led to legal and illegal collecting and inadvertent damage, especially prior to the 1970s when there was less concern for protecting these resources. Most paleontological material is buried considerably deeper than archaeological material and is therefore not regularly encountered by chance. Some Pleistocene-age animal remains could be recovered in archaeological deposits if the deposit were old enough. In such situations, the remains would represent subsistence use of the animal(s) by humans. The faunal material would be considered part of both the archaeological record and the regional paleontological record. Construction of DEW-Line and other military sites, and village-related development on the North Slope, have also likely contributed to the loss of paleontological resources, either from removal or destruction. Approximately 2,500 acres have been impacted by these developments.

Oil and Gas Exploration and Development Activities

Ground-disturbing activities associated with oil and gas exploration and development have likely impacted paleontological resources. The older, land-based 2-D seismic technology consisted of long, intersecting seismic lines that used either dynamite or vibrators as the energy source. In the early stages of acquisition on the North Slope, much less care was taken to protect the tundra from damage during data acquisition. Damage, then as now, can result from inadequate snow cover and inappropriate equipment. Early roads were bladed in the tundra, and over 500 acres of roads were constructed by mounding peat (NRC 2003). Thus, near-surface paleontological material could have been lost. Use of ice roads and improvements in seismic gathering techniques (3-D and 4-D technologies) have resulted in fewer impacts to the ground surface, and potentially to paleontological resources, than occurred in the past.

The excavation of gravel to construct roads, pads, and other facilities since the late 1960s has added to the loss of paleontological resources. Most mammalian fossils are of Quaternary age, which also is the age and origin of most North Slope gravel sources. Therefore, the more gravel deposits that are excavated for development activities, the greater possibility that impacts to paleontological resources would occur. Through 2001, over 6,300 acres have been disturbed for gravel mines on the North Slope, with over 5,000 acres of disturbance occurring along rivers where paleontological resources are often exposed or close to the surface.

During the past several decades, greater reliance on technologies that reduce the need for gravel to construct permanent roads and pads and reduce the size of the facility footprint, and a slowing of oil development activities, have substantially reduced the amount of area disturbed annually to extract gravel resources. In addition, state and federal regulations that require surveys for and prohibit the removal of paleontological resources (including Lease Stipulation 74), have also slowed the cumulative loss of paleontological resources.

Summary of Past Impacts and Their Accumulation

Paleontological research and excavation, past non-oil and gas development, recreation, and oil and gas exploration and development have contributed to the loss of paleontological resources, either from removal or destruction. If paleontological resources removed in the past have been preserved in museum or private collections, their losses would not accumulate. If they have been lost forever, the impacts of this lost resource persist today. Approximately 2,500 acres have been disturbed or covered with gravel for non-oil and gas development. Approximately 1,750 acres have been disturbed from bladed and peat roads, exploration sites, and airstrips. Gravel mining has disturbed over 6,300 acres, much of this area along rivers where paleontological resources are often exposed or are close to the surface. Another 9,200 acres have been covered with gravel to create pads and roads. Paleontological resources found in these areas could be damaged, destroyed, or buried under gravel. Recent technological developments, including use of ice roads and pads, Rolligons, horizontal drilling, and roadless development have reduced the amount of surface disturbance associated with exploration and development activities, with likely benefits to near-surface paleontological resources.

Future Effects and Their Accumulation

An estimated 500 and 4,000 acres could be disturbed from non-oil and gas, and oil and gas, development in the Planning Area and on the North Slope during the next 25 years, respectively (Table 4-37). An additional 4,000 acres could be impacted by 2050 if development occurs in the Northwest and South National Petroleum – Reserve. The North Slope region is approximately 57 million acres, while the Arctic Coastal Plain, where most oil and gas development would take place, comprises 13 million of those acres. Surface disturbance associated with all past and reasonably foreseeable non-oil and gas, and oil and gas, development would impact approximately 0.05 percent of the Alaska North Slope and 0.2 percent of the ACP. Of this, gravel mining would account for about 500 acres in the next 25 years. These actions have the potential to add to the cumulative loss of paleontological resources. Site reclamation would not reduce this loss, as paleontological resources would have already been lost during site disturbance and development.

New innovations in technology that reduce the amount of surface disturbance associated with oil and gas activities, enforcement of regulations that require the assessment and protection of paleontological resources before ground-disturbing activities can occur, and a slowing of oil and gas development on the North Slope, would contribute the future protection of paleontological resources and slow their cumulative loss. Assessments to identify and protect paleontological resources in gravel mine areas should minimize or avoid the loss of these resources.

Paleontological resources are not ubiquitous across the North Slope, and it is possible that they would not be impacted in the future. Since paleontological material is deeply buried, the location of plant and animal fossils is predictable only to a limited degree, and most fossil localities remain unknown, making assessment of cumulative impacts difficult. However, as new exploration and development occurs on the North Slope, more of the North Slope would be subjected to ground disturbance and there would be additional opportunities for paleontological resources to be impacted. If impacts were to occur, it is probable that impacts would be greatest in areas of high oil and gas potential.

Perhaps a better approach to this analysis is to examine the resource from the standpoint of vulnerability. In many settings, paleontological resources are well protected by nature, in that they are so deeply buried and completely encased in sediments or rock that virtually nothing can impact them aside from excavation. In other instances, they are located on or near the ground surface and are very susceptible to impacts. In most cases, surface or near-surface paleontological resources are more likely to be impacted as the result of exploration activities than by development, since most exploration-related operations occur in the low-light conditions of winter. Although snow cover may offer some protection, it also disguises surface manifestations, making them difficult to recognize and avoid. It is advisable to conduct surveys of proposed activity areas and overland travel routes during the snow-free months preceding the initiation of winter exploration activities.

Effects of Natural Events

Most paleontological material is exposed as a result of natural erosion. Typically, erosion occurs as a result of the action of flowing water, but also can occur as a result of wind, seasonal freezing and thawing, ground subsidence due to the thawing of unstable permafrost, and the movement of soil down slopes as it thaws. Natural erosion, and its impact on paleontological resources, is difficult to assess because in most cases it is regarded as discovery rather than a negative impact to the resource. Some of the most important paleontological resources are associated with river bank cuts and drainages.

Effects of a Large Oil Spill

The effects of a large oil spill on a paleontological deposit would be directly related to the time of year and the setting of the resource. If the spill were to occur during the time of year when the ground is not frozen, then the potential level of impact would be substantially higher. In an unfrozen setting, surface or near-surface paleontological resources would be impacted primarily from contamination that would affect radiocarbon and biomolecular analysis of the fossil material. Contamination would occur as a result of the cleanup rather than the actual spill. Impacts from both the spill and spill cleanup would be considerably less when the ground was frozen, although warm oil could melt the snow and permafrost and damage underlying paleontological resources. In the case of deeply buried paleontological deposits, neither the spill nor the subsequent cleanup (regardless of the time of year) would impact the resource. To date, there have been no large spills on the North Slope. The likelihood of a spill increases with time, but the potential for a spill would decrease as better equipment is used and spill prevention procedures are implemented, and oil production declines on the North Slope.

Global Climate Change

If global climate continues to warm, ice cover in the Arctic Ocean would shrink and sea level would. These events could accelerate the loss of shoreline along the Beaufort and Chukchi seas, where the shoreline is already rapidly retreating (an average of 8 feet per year; Reimnitz et al. 1985). Loss of coastline could also lead to the loss of paleontological resources on the North Slope. Higher sea levels and warmer temperatures could lead to greater snowmelt in spring and higher river levels, causing the loss of paleontological materials found along river banks. Warmer temperatures would also lead to warming and loss of permafrost, a shortening of the off-road tundra season (NRC 2003), and an increase the potential for seismic and other oil and gas activities to disturb near-surface paleontological resources. These impacts would be cumulative to those that have occurred in the past from other natural and man-made causes.

Contribution of Amendment Alternatives to Cumulative Effects

Nearly all of the Planning Area has been explored using 2-D seismic methods, and much of the northern half has been explored using 3-D methods. It is projected that approximately 200,000 (No Action Alternative) to 250,000 (alternatives B and C and the final Preferred Alternative) acres would be disturbed from seismic activities in the Planning Area under the alternatives, assuming 250 miles of 2-D and 37,500 miles of 3-D seismic lines over a 20-year period. This compares to 32,000 miles of seismic survey lines from 1990 to 2001 (NRC 2003). As seismic surveys were completed in the Planning Area and the remainder of the North Slope, the level of seismic activity and potential for impacts to paleontological resources would decline.

An estimated 300 (No Action Alternative) to 1,400 (Alternative C) (920; final Preferred Alternative) acres could be disturbed from oil and gas development in the Planning Area during the next 25 years if oil prices average $25 per bbl. The amount of area disturbed by the alternatives would comprise 0.002 to 0.011 (0.007) percent of the ACP, 0.0005 to 0.0024 (0.0016) percent of the North Slope, and up to 0.003 percent of the Planning Area. Lease stipulations and ROPs developed for the alternatives would minimize or prohibit exploration and development activities near major rivers, further reducing the likelihood of impacts to paleontological resources.

Conclusion

Ground-disturbing activities, including non-oil and gas development and oil and gas exploration and development, have impacted paleontological resources to some degree. However, because of their unpredictable location, isolated and rare occurrence, and varying depth of deposit, the level of past and future impacts is difficult to assess. If lease stipulations were to continue to apply to survey and inventory prior to exploration and development activities, the cumulative impact to paleontological resources would be expected to be minor in the Planning Area; similar state and federal regulations would help to protect these resources elsewhere on the North Slope. Paleontological resources are nonrenewable, and once displacement or contamination impacts them, their value may be greatly and irreversibly compromised. Cumulative impacts to paleontological resources across the North Slope and in the Planning Area in the future are expected to be minor, given the small amount of area impacted and implementation of measures to avoid river drainages and other areas with known or likely paleontological resources.

4.7.7.3 Soil Resources

Cumulative impacts to soils within the Planning Area would occur from exploration and development activities. The infrastructure for non-oil and gas and oil and gas development and transportation is the most important aspect of the cumulative analysis.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely caused soil loss and erosion on less than 100 acres in the Planning Area. In most cases, loss of soil and erosion would be temporary, lasting only a few years. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, scars in the soil persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground. Approximately 2,500 acres have been impacted (about 700 acres for DEW-Line sites and related development, and 1,800 acres for villages), and this loss of soil and soil productivity are likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the ACP has been surveyed since 1940, and soil was disturbed to varying degrees depending upon the soil and vegetation type, vehicle type, operator vigilance, and amount of snow cover. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still evident 8 years later, yet 5 percent of camp-move trails still showed moderate to high disturbance. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow. As noted earlier, about 50 acres of tractor trail/tundra scars persist today.

Use of newer technologies, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect vegetation, have reduced the level of impacts to vegetation and soil. In 2001, a study conducted the summer following seismic work, found little to no impacts to tundra under seismic lines on 30 percent of the plots studied (Jorgenson et al. 2003). Minor impacts were found on

66 percent and moderate impacts were found on 4 percent of the plots; no plots were highly impacted. Camp move trails in this study had little or no impacts on 18 percent, minor impacts on 54 percent, moderate impacts on 29 percent, and high impacts on none of the plots. Impacts to soil were minor in areas with good tundra cover. This study suggested that improvements in the equipment and procedures used for seismic surveys have reduced the amount of impact to tundra and soil.

Other sources of soil loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC 2003), in 2001, approximately 1,200 acres had been impacted by these sites in the past, and 740 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the landscape have persisted for decades, and are likely to persist for several more.

Oil and Gas Infrastructure. Peat and gravel roads and pads, and gravel mines have caused the direct loss of soil, and also led to the indirect loss of soil from thermokarst and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct over 9,200 acres of roads and pads, while gravel mines have impacted another 6,360 acres. Approximately 4,500 acres of gravel mines have been reclaimed, but only 70 acres of pads and roads. Thus, direct impacts to soil and soil productivity persist on over 12,000 acres (NRC 2003).

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003).

In general, most changes in the plant community and soils around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, approximately 2 acres of soil could be indirectly impacted due to hydrologic changes per 1 acre of development. If so, the condition of approximately 18,000 acres of soil may have been altered due to hydrologic changes on the North Slope.

Recent technologies, including roadless development, horizontal drilling, and closer spacing of wells on pads, and a slowing of oil field development, have greatly reduced the amount of surface disturbance needed to develop and produce oil. As a result, the annual amount of surface disturbance associated with gravel roads and pads has slowed substantially during the past 2 decades.

Spills. Overall, the effects of spills on soil have not accumulated on the North Slope because the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003).

Summary of Past Effects and Their Accumulation

Based on the above analysis, approximately 2,500 acres of direct impacts to soil from non-oil and gas activities persist today. Oil and gas activities have caused approximately 12,000 acres of direct impacts to soil that persist today; another 18,000 acres of indirect impacts have also occurred, some of which persist today. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to soil are additive to future impacts and would be likely to persist for several decades or more. However, the rate at which soil is disturbed by development has slowed substantially in recent years due to advances in technology and a slowing of oil field development on the North Slope.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

It is anticipated that villages will continue to grow in the future due to population growth and to provide services and infrastructure to support new oil and gas development on the North Slope. The amount of area that would be disturbed by new development is projected to increase by 2 percent annually.

Although not part of the development scenario for the Planning Area, it is reasonably foreseeable that the State of Alaska would build a new highway from the existing oil fields or the TAPS to the Planning Area. One proposal is to build a road from the Spine Road to Nuiqsut. Assuming a length of 18 miles (to connect the existing Spine Road to a proposed bridge at the Colville River) and assuming the same impacts for construction as for other gravel roads and pads, such a road would cover approximately 80 acres of soil for the road and 20 acres of soil would be lost from development of gravel mines. Another proposal is to build a road from TAPS to the Planning Area. This road could be 100 or more miles in length, and would directly impact 425 acres or more of soil and indirectly impact substantially more soil. An additional 80 acres of soil would be lost due to development of gravel mines.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. The number of acres disturbed annually by seismic activities would be similar to the amount of acreage that has been disturbed annually by seismic surveys during the past decade on the North Slope. An average of 1,300 miles of seismic trails is added each year, affecting about 40 to 1,300 mi^2 each year (NRC 2003). This area does not include the area between the trails, nor the area where recovery would occur. Based on soil and vegetation recovery studies, impacts to soil should be minor and short term (NRC 2003). It is assumed that seismic train moves would originate from Kuparuk, Barrow, or Umiat. Much of the distance from the point of origination to area where surveys were conducted would be on ice roads, reducing some of the impacts from surveys.

Oil Development and Production. An estimated 4,000 acres could be disturbed from oil and gas development on the North Slope during the next 25 years (Table 4-34). An additional 4,000 acres could be impacted by 2050 if development occurs in the Northwest and South National Petroleum – Reserve. Assuming 2 acres of indirect impacts to soil for each acre of direct impact, 16,000 acres of indirect impacts to soil could result from new development on the North Slope. Offshore development associated with leases in the Beaufort Sea could impact small areas along the coast for staging and storage of materials, but is unlikely to impact large areas of soil.

These impacts are additive to the impacts to soil that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. The North Slope region is approximately 57 million acres, while the Arctic Coastal Plain, where most oil and gas development would take place, comprises 13 million of those acres. Direct and indirect soil disturbance associated with all reasonably foreseeable oil and gas development would impact approximately 0.06 percent of the Alaska North Slope and 0.25 percent of the ACP. Of this, gravel mining would account for about 500 acres in the next 25 years. These actions have the potential to add to the cumulative loss of soil resources.

Oil Spills. Oil spills could impact soils by altering vegetation and from soil disturbance associated with clean-up activities. The oil alone would decrease plant growth, but oil spills probably would leave the surface organic mat intact. Spill cleanup, however, would be more likely to damage soils. Cleanups are not always well controlled; heavy traffic and digging, which are common cleanup methods, result in damaged soils. Oil-spill cleanup would mitigate impacts on soils only if cleanup methods and operations were very carefully controlled and minimized surface disturbance. The area affected would be limited to the area immediately adjacent to and covered by the spill.

Abandonment. Removal of aboveground facilities, pipelines, bridges, and power poles would have a minor impact on soils and permafrost. Soils and permafrost would remain unaffected for as long as pads and roads were maintained. Once maintenance of the roads and pads ceased, thaw subsidence in ice-rich areas would result in settling of the gravel structures into thermokarst troughs. Removal of the roads and pads would accelerate thaw subsidence, but would also accelerate the reclamation process.

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

Global Climate Change

Experimental studies have shown that a warming of the soil could lead to increased turnover of soil organic matter and redistribution of nitrogen from soils to vegetation (Nadelhoffer et al. 1992 *in* NRC 2003). If warming were accompanied by increased soil moisture, there could be a long-term loss of both carbon and nitrogen from the system, and potential losses of mineralized nitrogen from leaching. The depth of the active layer is likely to increase. If the climate continues to warm, the period in which there would be adequate snow and frost on the ground to support seismic and other exploration activities would decrease, and the potential for seismic activities to disturb the soil would increase. The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost (ACIA 2004). In other areas, warming of the surface permafrost could increase the formation of ponds, wetlands, and drainage networks, especially in areas with heavy concentrations of ground ice. Such thawing could also lead to large increases in sediment being deposited in rivers, lakes, and coastal marine environments, potentially impacting aquatic organisms.

As the permafrost warms, its ability to support structures diminishes, which could affect development on the North Slope. Thicker gravel may be needed to support structures, and abandoned work pads and roads could become unusable as they are cut up by deep polygonal troughs over thawing ice wedges, or by other thermokarst degradation.

Contribution of Amendment Alternatives to Cumulative Effects

Seismic activities could disturb up to 250,000 acres of soil under the action alternatives. The number of acres disturbed annually would be similar to the amount of acreage that has been disturbed annually by seismic surveys during the past decade in the Planning Area. It is assumed that seismic train moves would originate from Kuparuk and traverse about 30 miles east of the Planning Area in each direction. However, much of this distance would be along an ice road that is built annually from Kuparuk to the Alpine oil field, limiting most impacts of the seismic train outside of the Planning Area to the minor impacts associated with ice roads. Nonetheless, impacts associated with seismic operations occurring in the Northeast National Petroleum Reserve – Alaska would be additive with impacts from seismic operations in other portions of the National Petroleum Reserve – Alaska and across the North Slope.

If oil prices average $25 per bbl, development in the Planning Area would directly impact 300, 1,120, 1,380, and 920 acres of soil for alternatives A through D, respectively, and indirectly impact 400 to 2,400 acres of soil (1,600 acres under the final Preferred Alternative). Impacts associated with the Planning Area would be additive to past, present, and reasonably foreseeable future soil impacts on the North Slope. If global climate change persists, the effects to soil from non-oil and gas development, and oil and gas exploration and development, on the North Slope could be much greater than predicted.

Conclusion

Impacts to soils would occur from activities associated with oil and gas development, which would include exploration activities and construction of gravel pads, roads, airstrips, pipelines, and staging areas, and the excavation of material sites. The duration of the impacts would range from short term (1 to 5 years) if the soil was disturbed, and to up to several decades if the soil was removed. Overall, the area impacted by oil and gas development relative to the amount of available habitat on the ACP would be relatively small (approximately 0.25

percent), even with development occurring in the Planning Area. Nonetheless, impacts associated with exploration and development activities in the Planning Area would be additive with impacts from activities in other portions of the National Petroleum Reserve – Alaska and across the North Slope.

New innovations in technology that reduce the amount of surface disturbance associated with oil and gas activities, enforcement of regulations that require the assessment and protection of soil resources before ground-disturbing activities can occur, and a slowing of oil and gas development on the North Slope, would contribute the future protection of soil resources and slow their cumulative loss. Some soil would be restored as sites are abandoned and reclaimed. However, due to the harsh Arctic climate, it could take several hundred years for soil productivity to reach pre-disturbance levels on abandoned pads and roads.

4.7.7.4 Water Resources

Minor cumulative effects to water resources have occurred from non-oil and gas activities on the North Slope. Cumulative effects to water resources from oil and gas exploration and development in the Planning Area and across the North Slope could result from: 1) potential disturbance of stream banks or lake shorelines from oil and gas operations and the possible subsequent melting of permafrost (thermokarst erosion); 2) temporary blockages of natural channels and floodways during construction of roads and pipelines that would result in the disruption of drainage patterns; 3) increased erosion and sedimentation in rivers and lakes; 4) the removal of water from lakes for ice roads and pads; 5) increased use of the tundra for both oil and gas and non-oil and gas activities; 6) an increased amount of seismic surveys; 7) spills; and 8) removal of gravel from riverine pools and lakes.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration have the potential to impact water resources. However, all of these activities have also been ongoing for many years with minimal impact to water resources.

Temporary tent camps are generally located on existing pads or on well-drained soils along river terraces or uplands, set back from the stream or lakeshore with minimal surface disturbance. Excavation and collection activities have likely disturbed water bodies in the past. In the National Petroleum Reserve – Alaska, these activities must now must follow the National Outdoor Leadership School's "*Leave No Trace, Alaskan Tundra*" program to minimize impacts to vegetation and to reduce wastewater, human waste, and solid waste disposal. Similar care has been shown outside of the Reserve. Thus, permitted recreational activities would have minor cumulative impacts on water resources. Winter occupation or travel by vehicles or aircraft have resulted in minor spills. Most of these were cleaned up and had minor, short-term impacts on water resources.

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground. Approximately 2,500 acres have been impacted, and these activities have impacted water quality and altered natural drainage patterns. These effects on water resources are likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the ACP has been surveyed since 1940, and seismic activities have disturbed the soil, vegetation, and water over much of the ACP. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still evident 8 years later, yet 5 percent of camp-move trails still showed moderate to high disturbance. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow. About 50 acres of disturbance remains evident today, and it is likely that this disturbance has impacted nearby water bodies. Use of newer technologies, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect soil and vegetation, have reduced the likelihood of soil erosion and impacts to water quality.

Other potential water quality impacts are associated with exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC 2003), in 2001, approximately 1,200 acres had been impacted by these sites in the past, and 740 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the landscape, including soil erosion and sedimentation into nearby water bodies, have persisted for decades, and are likely to persist for several more.

Oil and Gas Infrastructure. Peat and gravel roads and pads, and gravel mines have caused the direct loss of soil, and also led to the indirect loss of soil from thermokarst and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct over 9,200 acres of roads and pads, while gravel mines have impacted another 6,360 acres. Approximately 4,500 acres of gravel mines have been reclaimed, but only 70 acres of pads and roads. Thus, direct impacts to water bodies from soil erosion and direct disturbance could persist on over 12,000 acres (NRC 2003).

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures that can impact water quality (NRC 2003).

Besides thermokarst and drainage alteration, erosion and sedimentation have been caused by construction activities or vehicular crossings, especially during periods of high stream flow or lake levels. Inadequate design or placement of structures, culverts, or bridges has altered natural sediment transport and deposition, creating scour holes or channel bars and impounding water. Improper placement or sizing of gravel fill has resulted in erosion from pads or roadbeds adjacent to streams or lakes. Long-term effects would be changes in channel morphology and in the composition of lake and stream bottom materials.

In general, most changes in the plant community, soil, and water quality around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, approximately 2 acres of water bodies could be indirectly impacted due to hydrologic changes per 1 acre of development. If so, hydrologic change may have occurred on approximately 18,000 acres on the North Slope.

Recent technologies, including roadless development, horizontal drilling, and closer spacing of wells on pads, and a slowing of oil field development, have greatly reduced the amount of surface disturbance needed to develop and produce oil. As a result, the annual amount of surface disturbance associated with gravel roads and pads has slowed substantially during the past 2 decades.

Gravel Mines. Improper siting of gravel-removal pits has resulted in changes to the configuration of stream channels or lakes, stream-flow hydraulics or lake dynamics, erosion and sedimentation, and ice damming and aufeis formation. Gravel removal for permanent gravel roads and drill pads has resulted in over 6,300 acres of surface impacts, over 5,000 of these acres associated with rivers. However, over 4,200 of these river-associated acres have been reclaimed, reducing cumulative effects to water resources on the North Slope and, at some sites, providing fish habitat.

Water Withdrawals. Removal of water from lakes, especially from fish-bearing lakes, for ice roads and pads during the winter months may have a minor cumulative impact. Regulations limit the drawdown in fish-bearing lakes to 15 percent of the under-ice volume. This restriction does not apply to non-fish bearing lakes. The impacts to water levels in lakes likely did not accumulate, as natural recharge processes are sufficient to recharge the lakes each year. However, the long-term effects of this activity on fish, and other aquatic organisms, are not well understood (NRC 2003).

Spills and Other Contaminants. Overall, the effects of spills on soil have not accumulated on the North Slope because the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003).

In 1976, drilling fluids from a site near Teshekpuk Lake broke through a retaining berm and flowed into Teshekpuk Lake. Although the amount of damage to the environment was minimal, all future reserve pits were designed to contain the total estimated volume of drill cuttings and muds below the level of the original tundra surface.

In the Prudhoe Bay area, trace metal contamination has been raised as a concern (Woodward et al. 1988; Snyder-Conn et al. 1997). Based on very limited sampling, Snyder-Conn et al. (1997) suggested that elevated levels of nickel and mercury exist in the snowpack near the ARCO gas-handling facility and that elevated levels of mercury, antimony, cadmium, copper, and lead exist near the NSB solid-waste incinerator. The total mercury concentration for this single snow sample near the gas-handling facility was 8.4 ppt, a few-fold higher than the chronic marine water quality standard of 1.2 ppt, but far below the acute toxic standard of 2,400 ppt.

Drilling Waste Disposal. In recent years, drilling wastes, which previously were stored in environmentally undesirable surface pits, have been injected into subsurface aquifers for permanent disposal. Although much of the water in aquifers below the impermeable permafrost is too saline to meet standards for a legally protected drinking water, some is not.

The North Slope of Alaska is largely classified as wetlands underlain by permafrost, which separates the surface-water system-active layer, lakes, streams-from the relatively isolated and little understood groundwater system of sub-permafrost formations (Williams 1970, Sloan 1987). Although water appears plentiful on the surface, the North Slope has an arid climate, and if a significant supply of fresh water exists in deep aquifers, it could be a valuable resource. There is little known about the effect of drilling waste disposal on subsurface aquifers and its cumulative effect (NRC 2003).

Marine Waters. Offshore activity in the Beaufort Sea has been limited. Activities that affect the quality of marine waters and flow patterns have included construction of gravel islands and causeways and discharges of materials. Only a few small spills have occurred in marine waters to date, but mechanical recovery, the method allowed by current regulations, is not efficient and only removes a small fraction of the spilled oil, especially in broken ice. Concerns about contamination of marine waters center primarily on the potential effects on marine organisms (NRC 2003).

There have been three permitted types of discharges to the Beaufort Sea over the life of the oil fields. First, individual facilities have discharges permitted under USEPA NPDES program. Second, small or localized discharges have been permitted under the North Slope General NPDES Permit. Third, exploratory drilling discharges were permitted under the Arctic General (or Beaufort General) NPDES Permit under either coastal effluent guidelines or offshore effluent guidelines (Wilson 2001).

Permitted NPDES discharges include effluents from seawater-treatment plants, desalination plants, sanitary-waste-processing units, deck drainage sumps (from offshore production facilities, such as Northstar), temporary construction dewatering, and occasional tests of fire suppression with water. These discharges are permitted for a specific facility, and there are monitoring and reporting requirements. The largest discharges under this program are ocean water and peat detritus (Wilson 2001).

Exploratory drilling discharges are covered under the USEPA Beaufort Sea General Permit and include disposal of drill cuttings and fluids from well-drilling operations. Although muds and cutting cannot be discharged onshore, offshore guidelines still allow discharges of muds and cuttings.

Monitoring is frequently required as a condition of discharge permits to ensure that discharges do not exceed water quality standards, are not toxic to marine organisms, do not degrade water quality, and do not pose a threat to human health. Thus, impacts from discharges to marine water were likely minor and have not accumulated.

Past Clean-Up Efforts in the Planning Area. In 1976, a cleanup program was initiated, based out of Point Lonely and Barrow. During the summer of 1976, over 23,500 drums were retrieved and 750,000 pounds of debris collected. In 1977, another 26,500 drums and 485 tons of debris were collected. In 1978, over 2 million pounds of debris were collected, primarily from the Skill Cliff Air Force Tower site and the Navy's Topagoruk and East Topagoruk test well sites. In 1979, another 1.8 million tons of debris were collected at old Navy sites and other sites in the National Petroleum Reserve – Alaska. Removal of this material lessened the likelihood of hazardous materials further impacting local water bodies.

Rehabilitation of pads and other disturbed sites began in the late 1970s, with the focus on lowering the drill pads and obliterating their straight edges, filling reserve pits, and revegetating sites. Germination success varied depending upon growing conditions during the summer; wet and foggy summers usually resulted in poor germination. It is estimated that about 550 acres were disturbed during the 1975-1982 USGS exploration program, that revegetation was attempted on 440 acres, and that vegetation became well established on nearly 400 acres by 1982.

Summary of Past Effects and Their Accumulation

Based on the above analysis, approximately 2,500 acres of direct surface disturbance from non-oil and gas activities have impacted water bodies and drainage patterns. Oil and gas activities have caused approximately 12,000 acres of direct impacts to lands on the North Slope, much of which consist of water bodies, and indirect impacts may have occurred on another 18,000 acres. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to water are additive to future impacts and would be likely to persist for several decades or more. Several spills have occurred on the North Slope, but their effects have been minor and have likely not accumulated. Effects of discharges from offshore facilities and subsurface injection of drilling wastes are largely unknown, but likely have had little cumulative effect on water quality on the North Slope. Large amounts of debris was left on the North Slope from exploration and military activities from 1940 to 1970 that impacted water quality, but clean-up efforts since the 1970s have removed much of this debris.

Future Effects and Their Accumulation

Increased use of material sites, use of lakes as a water source for ice roads, and dust created by additional traffic on existing roads would cause impacts to water resources in the future. Offshore oil and gas operations and the use of tankers to transport oil from the TAPS to west coast refineries could have a cumulative effect on marine and estuarine water resources.

An estimated 4,000 acres could be disturbed from oil and gas development on the North Slope during the next 25 years (Table 4-37). An additional 4,000 acres could be impacted by 2050 if development occurs in the Northwest and South National Petroleum – Reserve. Assuming 2 acres of indirect impacts to water bodies for each acre of direct impact, approximately 16,000 acres of indirect impacts to water bodies could result from development on the North Slope.

These impacts are additive to the impacts to water bodies that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Surface disturbance associated with all past and reasonably foreseeable non-oil and gas, and oil and gas, development would impact approximately 0.06 percent of the Alaska North Slope and 0.25 percent of the ACP. Of this, gravel mining would account for about 500 acres in the next 25 years. These actions have the potential to add to the cumulative loss and degradation of water resources.

The long-term effect of thermokarst erosion on water resources would persist, and new thermokarst erosion would be associated with new disturbance, especially in areas where the wave action of the water would accelerate the removal of the protective soil and vegetative cover. Fine-grained sediments melting out of the ice-rich permafrost would result in increased sediment erosion and changes to stream channel and bed morphology. Thermokarst erosion would also result from the cumulative effect of seismic activity on the tundra during winter months. Approximately 1 percent of the total cumulative line miles of seismic traverses would experience some level of thermokarst erosion to the tundra. An estimated 1,300 miles of seismic lines would be traveled annually, resulting in approximately 13 acres of impacts to water bodies each year. These impacts would accumulate and be additive to past effects to water bodies on the North Slope.

Natural drainage patterns can be disrupted when activities or structures divert, impede, or block flow in stream channels, lake currents, or shallow-water tracks. Since roads pose the single greatest impacting factor (diversions, impoundments, and increased sediment runoff), limiting the length of the roads, or the repeated use of roads, would provide a substantial reduction in impacts to water resources. Although most roads would be built during the winter months as ice roads, long-term oil and gas development in the Planning Area and the North Slope would require permanent gravel roads. These roads would impact shallow-water tracks and smaller stream channels and drainages.

Besides thermokarst and drainage alteration, erosion and sedimentation would be caused by construction activities or vehicular crossings, especially during periods of high stream flow or lake levels. Given that over 95 percent of the primary proposed development area (Barrow Arch) is comprised of water bodies, numerous bridge and culvert crossings would be needed where roads and pads are constructed. If culverts were properly sized and engineered, impacts to water flow from ice-blocking and other obstructions should be minimized. The major rivers should not be affected because lease stipulations would require bridges rather than culverts at crossings.

Improper siting of gravel-removal pits can result in changes to the configuration of stream channels or lakes, stream-flow hydraulics or lake dynamics, erosion and sedimentation, and ice damming and aufeis formation. Those changes would in turn result in long-term changes in stream channel and lakeshore sand and gravel-bar formation. Because gravel resources within the Planning Area are inadequate, new material sites or expansion of existing material sites would be likely. While these sites would require permits from the ADFG, it is possible that impedance and diversion of floodwaters, increased erosion and sedimentation, and increased thermokarst erosion adjacent to the material sites could occur. As noted above, most recent gravel pits have been sited on the tundra, rather than in rivers to minimize the effects described above. Gravel removal for permanent gravel roads and drill pads, however, would still present a long-term cumulative impact to the Planning Area and to the North Slope in general.

Removal of water from lakes, especially from fish-bearing lakes, for ice roads and pads during the winter months would be a moderate cumulative impact to the Planning Area and the North Slope in general. State regulations that apply to the North Slope and current and proposed lease stipulations and ROPs for the Planning Area limit the drawdown in fish-bearing lakes to 15 percent of the under-ice volume. This restriction does not apply to non-fish bearing lakes. Oil and gas exploration and development would require substantial volumes of water from lakes. Because the promising oil resources of the Planning Area and the North Slope are located in specific zones, lakes along these primary exploration and development zones would be used extensively for water during the winter months. This extensive use could have a long-term cumulative impact on the Planning Area, although restrictions imposed by the lease stipulations and ROPs would be effective in reducing these impacts on the Planning Area.

A large oil spill from oil and gas development in the Beaufort Sea would degrade the marine environment through the release of petroleum hydrocarbons into the water column. The hydrocarbon concentration could exceed the 1.5-ppm acute toxicity criterion for about a day in an area of about 0.8 mi^2. The 0.015-ppm chronic toxicity criterion also could be exceeded for 10 or more days in an area of about 4.6 to 17.4 mi^2. Small spills could exceed the acute-toxic level for less than a day, and chronic criterion could be exceeded for less than a month in an area of less than 100 km^2 (39 mi^2). An oil spill within the tundra in a fish-bearing lake could have substantial impact on the future fish resources of the lake and future use of the lake by wildlife and local natives. Although such a spill is not expected, and the history of oil spills in the North Slope suggests that such a spill is unlikely (NRC 2003), long-term use of the Planning Area for oil and gas development, especially near Teshekpuk Lake, could result in such a spill.

Tankering of oil resources derived from the Planning Area or other North Slope areas at the southern end of the TAPS could result in a large tanker spill, and the oil could contact nearshore areas in Prince William Sound or the Gulf of Alaska in a relatively non-weathered state. It is estimated that such a spill would affect up to 10 percent of the water quality within the affected area, but could be larger and be similar to the Exxon Valdez spill. Recovery could take months to years, depending on the nature and location of the spill and wave energy in the spill area.

The quality of freshwater within the Planning Area should not be affected by any of the major projects considered in the cumulative case, unless there was a large oil spill within or near a fish-bearing lake. The effects of construction activities should be short term and have the greatest impact in the immediate vicinity of the activity. Construction activities are not expected to introduce or add any chemical contaminants. Removal of water from lakes during the winter months should not affect water quality. Only a large oil spill within or near a fish-bearing lake would present a possible impact to long-term water quality.

Global Climate Change

Global climate change could lead to increased evaporation and, in turn, to increased precipitation (this is already occurring). Over the Arctic as a whole, annual total precipitation is projected to increase by roughly 20 percent by the end of this century, with most of the increase coming as rain.

However, while there is high confidence that temperatures will rise and total annual precipitation will increase, it is not known whether the increase in precipitation will keep up with the warming and rate of evaporation. If precipitation does not keep up with the rate of evaporation, land areas could dry out.

Another concern is the degree of permafrost thawing and subsequent drainage of water from the land. For example, summer thawing now results in a large amount of water on the surface. However, this moisture could be lost if the depth of the active layers increases. This could result in desertification in some areas as warming continues (ACIA 2004).

Contribution of Amendment Alternatives to Cumulative Effects

Direct impacts to water quality from surface disturbance activities on the Planning Area would occur on approximately 250 (No Action Alternative) to 1,500 (Alternative C) acres (assuming an oil price of 25 per bbl), and indirect impacts would occur on 400 to 2,400 acres. Thus, direct and indirect impacts to water quality would occur on less than 0.01 percent of the Planning Area.

Approximately 600,000 acres in the TLSA would be closed to leasing under Alternative A. Wetland habitat comprises approximately 95 percent of this area. Thus, protection to water bodies would be greatest under Alternative A. Approximately 213,000 acres in the TLSA are closed to leasing under Alternative B, while Teshekpuk Lake (211,000 acres) is deferred from leasing under the final Preferred Alternative. Based on amount of surface area protected, water bodies would be nearly equally protected under these two alternatives. However, approximately 20 percent more development is projected to occur under Alternative B than the final Preferred Alternative, increasing the likelihood of impacts to aquatic bodies from construction of roads and pads, gravel mining, and other development and production activities under Alternative B. Under Alternative C, the entire Planning Area would be open to leasing. The amount of area disturbed from oil and gas activities is projected to be highest for this alternative. Thus, Alternative C would provide less protection to water resources than the other alternatives. The lease stipulations and ROPs provided for each alternative should reduce impacts from oil and gas exploration and development and keep impacts to water resources to a minor to moderate level. Still, future impacts to water resources would occur and would accumulate with past impacts.

Conclusion

Assuming cumulative effects to water resources would occur in relation to the amount of surface disturbance across the North Slope, direct and indirect cumulative effects could occur on approximately 0.06 percent of the North Slope and 0.25 percent of the ACP. Of this, gravel mining would account for about 500 acres in the next 25 years. The majority of the impacts would result from oil and gas development activities, with construction of roads, permanent drill pads, and water use from lakes during the winter months being the major contributors. Impacts from activities other than those associated with oil and gas development (including any oil and gas-related roads) would be minor. Because of the abundance of water resources on the North Slope, the overall cumulative impact to water resources on the North Slope and in the Planning Area would probably be small in magnitude and most impacts would be local in nature. These local impacts could be substantial and long term because of the concentration of promising oil and gas plays in specific zones within the Planning Area. The implementation of the lease stipulations and ROPs required for protection of water resources under each alternative should reduce the cumulative effect to water resources from oil and gas, and non-oil and gas, activities in the Planning Area to an acceptable level. Impacts associated with the Planning Area would be additive to past, present, and reasonably foreseeable future impacts on the North Slope.

4.7.7.5 Vegetation

Vegetation is a renewable resource; impacts to vegetation do not necessarily accumulate and are often reversible. However, due to the harsh climate and short growing seasons on the North Slope, it may take plants decades to centuries to recover from a disturbance. Oil and gas exploration and development in the Planning Area are the primary contributing activities, in terms of cumulative effects, on vegetation on the North Slope. The greatest impacts occur where vegetation is removed or buried under gravel or other material that destroys the vegetation. In the long term, global climate change may have a greater and more persistent effect on vegetation on the North Slope than oil and gas activities. Other factors that contribute to the cumulative loss of vegetation include permitted activities such as non-oil and gas overland moves and development, scientific data gathering, and recreational use by the public. Additional vegetation may be lost by indirect effects associated with dust from gravel roads and pads, and from alteration of natural drainage flows resulting from development.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely caused the loss of less than 100 acres of vegetation in the Planning Area. In most cases, loss of vegetation would be temporary, lasting only a few years. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, vegetation scars persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground cleared of vegetation. Approximately 2,500 acres have been impacted, and this loss of vegetative cover is likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the ACP has been surveyed since 1940, and vegetation was disturbed to varying degrees depending upon the soil and vegetation type, vehicle type, operator vigilance, and amount of snow cover.. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still evident 8 years later, yet 5 percent of camp-move trails still showed moderate to high disturbance. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow. As noted earlier, about 50 acres of tractor trail/tundra scars persist today.

Use of newer technologies, including vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect vegetation, has reduced the level of impacts to vegetation. In 2001, a study conducted the summer following seismic work, found little to no impacts to tundra under seismic lines on 30 percent of the plots studied (Jorgenson et al. 2003). Minor impacts were found on 66 percent and moderate impacts were found on 4 percent of the plots; no plots were highly impacted. Camp move trails in this study had little or no impacts on 18 percent, minor impacts on 54 percent, moderate impacts on 29 percent, and high impacts on none of the plots. This study suggests that improvements in the equipment and procedures used for seismic surveys has reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of low or little to no impacts and few, if any, highly impacted sites. Longer-term studies are needed to determine if these impacts persist for more than a few years and accumulate.

Other sources of vegetative loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and peat and gravel exploration roads. Based on *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC 2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and 1,130 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. Over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago.

Oil and Gas Infrastructure. Gravel roads and pads, and gravel mines have caused the direct loss of vegetation, and also led to the indirect loss of vegetation and soil from thermokarst and alteration of natural drainage patterns. Gravel has been used to construct over 9,200 acres of roads and pads, while gravel mines have impacted another 6,360 acres. Approximately 4,500 acres of gravel mines have been reclaimed, but only 70 acres of pads and roads. Thus, direct impacts to vegetation persist today on over 12,000 acres (NRC 2003).

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003).

In general, most changes in the plant community and soil around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, approximately 2 acres of vegetation could be indirectly impacted due to hydrologic changes per 1 acre of development. If so, the condition of approximately 18,000 acres of vegetation may have been altered due to hydrologic changes on the North Slope.

The passage of vehicle traffic over gravel pads and roads results in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel can smother vegetation. The effects of dust on vegetation include early snowmelt, reduced soil nutrient concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). These studies found that plant species richness was reduced near gravel structures, particularly in naturally acidic soils. A decrease in acidophilus mosses, some lichen species, and certain heath taxa altered species composition (Walker and Everett 1987). In areas that experience heavy dust fallout, native plant communities have been killed and replaced by early-successional colonizers and species more tolerant of the altered site conditions. The magnitude of these effects depends on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed are generally low on in-field roads, which have limited dust impacts to vegetation. Based on assumptions used in this amendment, approximately 30 acres of vegetation have been impacted by dust for each 100 acres of development, suggesting that 2,700 acres of vegetation have been indirectly affected by gravel roads and pads on the North Slope. These impacts are likely to persist as long as vehicle travel occurs on the pads and roads.

The material used for gravel fill can also impact vegetation near gravel structures. Saline material used as fill increases the salinity of water draining off of or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Spills. Overall, the effects of spills on vegetation have not accumulated on the North Slope because the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003).

Air Quality. The effects of air quality on vegetation near industrial facilities on the North Slope appear to be minimal (Kohut et al. 1994; NRC 2003), although few studies have been conducted. Air quality currently meets federal and state air quality standards. Based on the few studies that have been conducted, these standards appear to be sufficient to have protected vegetation on the North Slope, although impacts to lichens from SO_2 have been shown to occur at concentrations well below the 3-hour standard, and the protection these limits on emissions provide to lichen species have been questioned (NRC 2003).

Summary of Past Impacts and Their Accumulation

Based on the above analysis, approximately 2,500 acres of direct impacts, and 5,000 acres of indirect impacts to vegetation from non-oil and gas activities persist today. Oil and gas activities have caused approximately 12,000 acres of direct impacts, and 21,000 acres of indirect impacts to vegetation that persist today. Since most of these impacts are associated with non-oil and gas residential and commercial development, and oil and gas activities, these impacts to vegetation are additive to future impacts and would be likely to persist for several decades or more.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use and other activities, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, would continue to cause the loss of minor amounts of vegetation. In most cases, loss of vegetation would be temporary, lasting only a few years. DEW-Line sites and other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future, and for villages, likely increase in size, causing the loss of additional vegetation. The amount of area that would be disturbed by new development is projected to increase by 2 percent annually.

Although not part of the development scenario for the Planning Area, it is possible that the State of Alaska would build a new highway from the existing oil fields or the TAPS to the Planning Area. One proposal is to build a road from the Spine Road to Nuiqsut. Assuming a length of 18 miles (to connect the existing Spine Road to a proposed bridge at the Colville River), and assuming the same impacts for construction as for other gravel roads and pads, such a road would cover approximately 80 acres of vegetation; an additional 20 acres of vegetation would be impacted for a gravel mine. Another proposal is to build a road from TAPS to the Planning Area. This road could be 100 or more miles in length, and would directly impact 425 acres or more of vegetation from road construction and another 80 acres of vegetation due to gravel mining; indirect impacts to vegetation would be substantially greater.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. An average of about 1,300 miles of seismic trails is added each year on the North Slope. Based on projections developed for the Planning Area, this activity could impact up to 100 acres of vegetation annually that would still show moderate to high levels of disturbance a decade later. However, based on recent studies of the use of newer seismic technologies, it is likely that impacts to vegetation that persist for a decade or more would be substantially less than this estimate (Jorgenson et al. 2003).

Other sources of vegetative loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. These have been replaced in recent years by ice roads, airstrips, and drilling pads to reduce costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, only a small amount of vegetation is likely to be effected in the long term by exploration sites and facilities.

Oil and Gas Infrastructure. Development activities that could contribute to cumulative effects to vegetation on the North Slope include oil development in other areas, including the Northwest and South National Petroleum Reserve – Alaska; federal and state offshore oil development (through the construction of supporting onshore infrastructure); state onshore oil development; oil transportation; and road construction. All of these activities involve construction of infrastructure that would destroy vegetation within the immediate footprint of the project and indirectly affect vegetation through dust, flooding, changes in natural drainage patterns, snow drifting, increased water and air pollution, and oil and chemical spills that could cause changes in the plant species composition and community types.

Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, it is estimated that an additional 3,500 acres would be covered by gravel, and 500 acres impacted by gravel mines, in the next 25 years, much of this in the Planning Area. Approximately 9,200 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. An additional 4,000 acres of vegetation could be impacted by oil and gas activities between 2030 and 2055; another 9,200 acres would be indirectly impacted by development.

These impacts are additive to the impacts to vegetation that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct (21,000 acres) and indirect (36,000 acres) impacts that could still persist in 2050, direct and indirect impacts to vegetation from activities on the North Slope would impact approximately 0.43 percent of the ACP and 0.10 percent of the North Slope. These estimates do not take into account the quality of the vegetation that would be impacted on the North Slope. If rare plants or unusual or scarce plant communities are harmed or lost, impacts to vegetation could be greater based on qualitative factors.

Spills. Oil produced as a result of development in the Planning Area would contribute to less than 13 percent of future spills from TAPS, but would increase the number of onshore oil spills and would likely impact tundra systems in some instances.

Air Quality. Emissions on the North Slope are expected to decrease as the result of an overall downward trend in oil production. Greater reliance on technologies that reduce the need for permanent roads and pads, and reduce the size of the facility footprint, also would result in lower levels of particulate matter emissions. Still, impacts to vegetation from past and future air pollutants could accumulate.

Sensitive Plant Species. Development would be unlikely to have a high negative effect on plant species or communities. However, if facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be high. Three rare North Slope plant species are known to occur in the Planning Area, and four other rare species are known to occur on the North Slope but have not been documented, in the Planning Area. Sabine grass is an aquatic grass that rarely occurs between the pendent grass and sedge zones in lakes and ponds. This species is known in few locations north and northeast of Teshekpuk Lake. This area would be open to development under the final Preferred Alternative and alternative C, but not under alternatives A or B. Stipulated cinquefoil has been found at Umiat; this Asian species is found in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. This species would be protected by setbacks along rivers in the Planning Area and by the designation of the Colville River Special Area. Muir’s fleabane, Drummond’s bluebell, and Hartz’s bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, and rock outcrops. These habitats are the primary sources of gravel fill used during construction and development (NRC 2003) and could be impacted by development in these areas. Because of the limited number of plants comprising these populations, loss of one or more plant populations could be a significant cumulative impact to the species.

Abandonment. The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

Recovery of disturbed sites on the North Slope is complicated by the fact that any disturbance of the insulating vegetative mat can melt the underlying permafrost, a process that is extremely difficult to reverse and that can continue long after the initial disturbance ends. Finally, gravel pads and roads, which account for the vast majority of the directly affected habitat on the North Slope, retain moisture and nutrients poorly and thus slow recovery processes.

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Reclamation of oil fields, even over a long period of time, would reduce some of the cumulative effects of vegetative loss.

Global Climate Change

Temperatures in Alaska, and throughout the Arctic, are thought to have fluctuated considerably over the last few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest century in the last 400 years (Overpeck et al. 1997; IPCC 2001; ACIA 2004). As predicted by global climate models, Alaska's surface air temperature has warmed throughout much of the state since at least the mid-1970s (IPCC 2001, ACIA 2004). Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope. However, the large amount of natural variation inherent in the system limits our current understanding of the consequences of climate change.

Chapin et al. (1995) suggested that climate change might be altering the species composition of the Alaskan Arctic tundra. A warmer, wetter environment with a longer growing season could greatly affect the productivity and growth form composition of tundra by causing a more rapid release of nutrients from decomposing soil organic matter (Nadelhoffer et al. 1991). Similarly, changes in the water table, which alter decomposition and nutrient availability, substantially alter the carbon balance of tundra and taiga microcosms (Billings et al. 1983; Funk et al. 1994). These changes may eventually lead to shifts in the composition of Arctic tundra toward more shrub species at the expense of grass and sedge species. Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low lying tundra areas, increasing aquatic and wet tundra vegetation types and erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to vegetation from changes associated with thermokarst.

Contribution of Amendment Alternatives to Cumulative Effects

Long-term impacts to vegetation from seismic surveys in the Planning Area would occur on approximately 150 (Alternative A) to 2000 (alternatives B, C, and D) acres. Impacts from ice road construction would occur on another 210 acres annually, while impacts from ice pads would occur on 30 to 270 acres during the life of the project; these impacts to vegetation would be short-term and would not accumulate.

If oil prices average $25 per bbl, development in the Planning Area could directly impact approximately 300, 1,120, 1,380, and 920 acres, and indirectly impact 450, 2,360, 2,730, and 1,890 acres of vegetation for Alternatives A through D, respectively. These impacts would be long-term and would accumulate. Total direct and indirect impacts to vegetation would occur on 0.02 (No Action Alternative) to 0.09 (Alternative C) percent of the Planning Area.

Conclusion

Impacts to vegetation on the North Slope from oil and gas exploration and development are expected to be additive with respect to impacts from other past, present, and future non-oil and gas and oil and gas activities. The impacts in the Planning Area would increase the total amount of vegetation impacted by all oil and gas development, but would not be expected to have synergistic effects that would affect additional acreage. The area impacted by oil and gas development, relative to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small. The four alternatives differ in the acreage of vegetation that would be impacted. The No Action Alternative would contribute a smaller amount to cumulative vegetation loss across the North Slope than the action alternatives. The final Preferred Alternative would result in less vegetation loss than alternatives B and C.

4.7.7.6 Wetlands and Floodplains

In compliance with Executive Order 11990, Protection of Wetlands and Floodplains, the BLM has prepared an impact analysis on those areas within Planning Area that are considered to have the function and value of wetlands, as described in Section 3.3.2 (Wetlands and Floodplains). Approximately 95 percent of the ACP in the Planning Area consists of wetlands. Resources included in the summary discussion below are classified as having the function and value of wetlands and floodplains on the North Slope. The reader should read the soil (Section 4.7.7.3), water (Section 4.7.7.4), and vegetation (Section 4.7.7.5) resource sections for more detailed information on the cumulative effects to these resources.

Past Effects and Their Accumulation

Soil Resources

Based on the analysis for soil resources, and assuming approximately 95 percent of past disturbance areas were wetlands, approximately 2,400 acres of direct impacts to wetland soil from non-oil and gas activities persist today. Oil and gas activities have caused approximately 11,400 acres of direct impacts to wetland soil that persist today; another 17,100 acres of indirect impacts have also occurred, some of which persist today. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to soil are additive to future impacts and would be likely to persist for several decades or more. However, the rate at which wetland soil is disturbed by development has slowed substantially in recent years due to advances in technology and a slowing of oil field development on the North Slope. In addition, greater effort has been placed on avoiding wetlands when siting permanent facilities.

Water Resources

Based on the above analysis, direct and indirect effects from non-oil and gas activities, especially those associated with activities at villages, and oil and gas activities have caused approximately 14,500 acres of direct impacts to lands on the North Slope, much of which consist of water bodies; indirectly impacted water bodies and flows on another 18,000 acres. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to water are additive to future impacts and would be likely to persist for several decades or more. Several spills have occurred on the North Slope, but their effects have been minor and have likely not accumulated. Effects of discharges from offshore facilities and subsurface injection of drilling wastes are largely unknown, but likely have had little cumulative effect on water quality on the North Slope. Large amounts of debris was left on the North Slope from exploration and military activities from 1940 to 1970 that impacted water quality, but clean-up efforts since the 1970s have removed much of this debris and reduced effects to water.

Vegetation

Based on the above analysis, approximately 2,400 acres of direct impacts, and 4,800 acres of indirect impacts to wetland vegetation from non-oil and gas activities persist today. Oil and gas activities have caused approximately 11,400 acres of direct impacts, and 20,000 acres of indirect impacts to wetland vegetation that persist today. Since most of these impacts are associated with non-oil and gas residential and commercial development, and oil and gas activities, these impacts to wetland vegetation are additive to future impacts and would be likely to persist for several decades or more.

Future Effects and Their Accumulation

Soil Resources

Oil and gas exploration and development and other activities on the North Slope have impacted, and will impact in the future, a very small fraction of the wetland soil on the North Slope. An average of about 1,300 miles of seismic trails is added each year on the North Slope. Based on projections developed for the Planning Area, this activity could impact up to 100 acres of wetland soil annually. However, based on recent studies of the use of newer seismic technologies, it is likely that impacts to wetland soil that persist for a decade or more would be substantially less than this estimate (Jorgenson et al. 2003).

Other sources of wetland soil loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. These have been replaced in recent years by ice roads, airstrips, and drilling pads to reduce costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, only a small amount of wetland soil is likely to be effected in the long term by exploration sites and facilities.

Water Resources

Water use by North Slope villages and oil and gas activities will continue to draw from local surface water sources. Water is abundant on the North Slope, and impacts should be localized and minimal.

The amount of wetland area directly and indirectly impacted by oil and gas exploration and development activities in the Planning Area would be a very small portion of the ACP (0.04 percent). Direct and indirect impacts to surface water resources from past, present, and reasonably foreseeable future development would occur on approximately 0.4 percent of the ACP and 0.1 percent of the North Slope. Impacts associated with the Planning Area would be additive to past, present, and reasonably foreseeable future impacts on the North Slope, although it is expected that water resource characteristics and quality would improve once oil and gas exploration and/or development activities cease in an area.

Oil and gas activities may produce short-term local impacts to water quality. Oil spills can create short and long-term impacts to surface water. A crude oil spill from a tanker could cause short-term water quality impacts to saltwater along the tanker routes south of Valdez.

Vegetation

The northern portion of the North Slope in general has a greater proportion of wetlands and is thought to be the area with the greatest oil and gas potential. Impacts to wetlands on the North Slope from oil and gas exploration and development are expected to be additive with respect to impacts from other present and future oil and gas activities outside of the Planning Area. The impacts in the Planning Area and on the North Slope would increase the total amount of wetland vegetation impacted by oil and gas development. The area impacted by oil and gas development, relative to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small, even if development occurs in the Planning Area. It is estimated that direct and indirect impacts to wetland vegetation would occur on 0.4 percent of the ACP and 0.1 percent of the North Slope.

Impacts to floodplains could occur from river channel crossings by pipelines and roads, which could destroy vegetation where bridge pilings or VSMs were required for the crossing. Construction of a buried pipeline under the river channel would also have impacts to floodplain vegetation in portions of the floodplain where the pipeline was buried. These impacts would be additive with impacts from other developments occurring on the North Slope.

Much of the gravel used for the construction of roads, pads and airstrips on the North Slope has been obtained from deposits in river floodplains. Impacts from these activities include habitat modifications, caused by increased braiding and spreading of flows (Woodward-Clyde Consultants 1980, NRC 2003). Established guidelines have largely restricted gravel mining to deep mining in upland pits, which may be flooded upon abandonment to create aquatic habitat including fish overwintering areas (NRC 2003). Approximately 500 acres of wetland vegetation would be disturbed by the establishment of gravel extraction sites on the North Slope; this acreage could be higher if one or more roads were built to connect the Dalton Highway to the National Petroleum Reserve - Alaska. These impacts would be additive with other impacts to floodplains across the North Slope, but the extent of impact would depend on the availability of gravel from upland areas.

Abandonment

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for wetland sites (AOGA 2001).

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Removal of gravel fill has recently been done in wetlands, and preliminary studies suggest that wetland mosaics of vegetation can be restored, although the method is expensive and finding acceptable locations for the fill can be difficult. Open-pit gravel mine rehabilitation typically involves converting mine sites to wetlands, including lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats.

Global Climate Change

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost (ACIA 2004). In other areas, warming of the surface permafrost could increase the formation of ponds, wetlands, and drainage networks, especially in areas with heavy concentrations of ground ice. Such thawing could also lead to large increases in sediment being deposited in rivers, lakes, and coastal marine environments, potentially impacting aquatic organisms.

Global climate change could alter species composition, increasing the prevalence of deciduous shrubs and decreasing the prevalence of wetland sedges and grasses, and could greatly influence wetlands through hydrological changes. Chapin et al. (1995) suggested that climate change might be altering the species composition of the Alaskan Arctic tundra. Global climate changes may eventually lead to shifts in the composition of Arctic tundra toward more shrub species at the expense of grass and sedge species. Warmer soil temperatures are likely to increase thermokarst and increases in sea level may inundate low lying tundra areas increasing aquatic and wet tundra vegetation types and increase erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development potentially leading to greater impacts to vegetation from changes associated with thermokarst.

Contribution of Amendment Alternatives to Cumulative Effects

Seismic activities could disturb up to 238,000 acres of wetland soil, water, and vegetation under alternatives B, C, and D over a 25-year period, and 48,000 fewer acres would be disturbed under the No Action Alternative; these impacts would be short term. The number of acres disturbed annually would be similar to the acreage that has been disturbed annually by seismic surveys during the past decade on the North Slope. Based on vegetation recovery studies, these impacts to wetland soils should be minor and short term (NRC 2003). It is assumed that seismic train activities would originate from Kuparuk and traverse about 30 miles of lands east of the Planning Area in each direction. However, much of this distance would be along an ice road that is built annually from Kuparuk to the Alpine field, limiting most impacts of the seismic train outside of the Planning Area to the minor impacts associated with ice roads. Nonetheless, impacts associated with seismic operations occurring in the Northeast National Petroleum Reserve – Alaska would be additive with impacts from seismic operations in other portions of the National Petroleum Reserve – Alaska and across the North Slope.

All of the Northeast National Petroleum Reserve – Alaska would be open to oil and gas leasing under Alternative C. Land unavailable for leasing and surface activity under the No Action Alternative, Alternative B, and the final Preferred Alternative would prevent development in areas that are predominately wetlands. The Goose Molting Area, in particular, contains a large percentage of the wetland vegetation types preferred by waterfowl, including aquatic vegetation dominated by water sedge and pendent grass. Under Alternative C, these areas would be more likely to be developed, and these vegetation classes would likely be impacted to a greater extent, than under any of the other alternatives. Under Alternative C, actions would contribute to cumulative wetland loss on the North Slope to a greater extent. Alternative B would contribute more to wetland loss than would the final Preferred Alternative. Assuming that 95 percent of the disturbance area would be to wetlands, approximately 760, 3,300, 4,000, and 2,670 acres of wetland soil, water, and vegetation resources would be directly and indirectly impacted by alternatives A through D, respectively. Total direct and indirect impacts to wetlands would occur on 0.02 (No Action Alternative) to 0.09 (Alternative C) percent of the Planning Area, and would comprise from 0.001 to 0.007 percent of the area impacted on the North Slope.

Impacts to floodplains could occur from river channel crossings by pipelines and roads, which could destroy vegetation where bridge pilings or VSMs were required for the crossing. Construction of a buried pipeline under the river channel would also have impacts to floodplain vegetation in portions of the floodplain where the pipeline was buried. Compared to the No Action Alternative, Alternative B, and the final Preferred Alternative, the increased development under Alternative C would likely result in greater impacts, since additional river crossings would probably be necessary and the likelihood of buried river crossings would also increase. These impacts would be additive with impacts from other developments occurring on the North Slope.

Much of the gravel used for the construction of roads, pads and airstrips on the North Slope has been obtained from deposits in river floodplains. Impacts from these activities include habitat modifications, caused by increased braiding and spreading of flows (Woodward-Clyde Consultants 1980, NRC 2003). Established guidelines have largely restricted gravel mining to deep mining in upland pits, which may be flooded upon abandonment to create aquatic habitat including fish overwintering areas (NRC 2003). Approximately 20 to 285 acres of wetland vegetation are likely to be disturbed by the establishment of gravel extraction sites in the Planning Area. These impacts would be additive with other impacts to floodplains across the North Slope, but the extent of impact would depend on the availability of gravel from upland areas.

Conclusion

Approximately 95 percent of the ACP in the Planning Area consists of wetlands; a similar percentage of wetland area was assumed for the North Slope. The ACP is also the area where the most significant oil and gas discoveries have occurred, and where future major discoveries are most likely. In addition, most non-oil and gas development associated with villages and military facilities occurs within this area. Thus, water resources have been effected by past activities, and will be susceptible to effects from future development, especially spills. New technologies, including use of low-impact equipment and less reliance on gravel roads and pads have reduced the potential for impacts to water resources. However, other technologies, including use of ice roads and pads, may have effects on water resources that are not well understood, but could be substantial long-term. Cumulative effects from human-induced activities on the North Slope, coupled with the potential cumulative effects of global climate change, could result in substantial alteration of North Slope wetland soil, water, and vegetation in the future.

4.7.7.7 Fish

Freshwater and Anadromous/Amphidromous Fish

The life cycles of freshwater and diadromous fishes on the North Slope are adapted to the region's long winters and low productivity (Craig 1984, 1989a, b; Power 1997). After break-up, fish move quickly during the brief summer into many habitats, often at great distances from the wintering area. For example, Arctic cisco from the Colville River can return to spawning areas more than 370 miles from the wintering area (Gallaway and Fechhelm 2000). Locating a suitable wintering area at the end of the summer is critical to survival. Craig (1989a, b) estimated that substantially less than 5 percent of stream habitat remains available to fish by late winter. These widespread movements, and the greatly restricted area of habitat available to fish in winter, make many of these species highly vulnerable to the effects of oil and gas exploration and development.

A number of effects could impact fish on the North Slope and accumulate. These include subsistence and commercial fishing; disturbance of fish during seismic operations; loss and alteration of habitat due to exploration and development, including effects from drainage diversions and causeways; spills; and global climate change.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely caused surface disturbance on less than 100 acres in the Planning Area. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, scars in the vegetation persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

Of the 17 species taken by subsistence fishermen on the North Slope, Arctic cisco and broad whitefish have the highest subsistence value. Most subsistence fishing occurs during the summer and fall and is especially important to the coastal villages. An average of 40,800 pounds of Arctic cisco was harvested annually from the Colville River Delta each fall from 1985 to 1998, with an additional 7,100 to 8,800 pounds taken near Kaktovik (Craig 1987, Fuller and George 1997). The broad whitefish harvest by North Slope villages is estimated to be more than 62,000 pounds annually (Fuller and George 1997; Hepa et al. 1997), although in some years fish harvests can be substantially larger.

Based on surveys conducted in the late 1980s and early 1990s, Barrow residents harvested from 50,000 to 110,000 pounds of fish per year, or about 11 percent of the total subsistence harvest (see Appendix J). The estimated harvest of whitefish for Barrow in 1989 was over 90,000 pounds (SRBA and ISER 1993). Atqasuk residents harvested approximately 12,000 pounds of fish annually, or 37 percent of their subsistence harvest. Nuiqsut residents harvested from 50,000 to 90,000 pounds of fish annually, or 30 percent of their subsistence harvest. Only a few thousands pounds of fish were harvested annually by Anaktuvuk Pass residents. Small numbers of fish are caught by recreational fishermen during float trips on the Colville River and fishing near villages. Fish harvested for subsistence and recreational purposes comprise only a small portion of the fish population and these effects to fish at the population level would not accumulate.

Some fish habitat has been lost due to construction of DEW-Line sites and other military construction, and residential, commercial, and industrial development associated with villages and airstrips. Approximately

2,500 acres have been disturbed by these developments, but since these sites were often located on high ground, there would have been only minor loss of fish habitat.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

When seismic exploration was conducted with explosives, there was potential for harming fish that were exposed to large, rapid changes in ambient pressure. The advent of vibrating equipment has reduced this concern, because the energy it generates is much less than the energy generated by explosives. The ADFG blasting standards require that the instantaneous change in pressure resulting from any explosion must remain below 0.02 megapaseals (Mpa; 2.7 psi). Results of a recent field test involving vibrators on ice, over water, indicate that peak pressure changes below a vibrator can be as low as 0.01 Mpa (1.57 psi). In addition, the energy velocity appears to be many times slower than velocities known to harm fish. When converted to energy, the Vibroseis machines transfer many times less energy to the water than do airgun arrays. It is unlikely that impacts to fish populations have accumulated from seismic surveys.

As discussed above, seismic vehicles have impacted the tundra and could have impacted some fish habitat. Use of newer technologies, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect vegetation, have reduced the level of impacts to tundra and potential fish habitat. Lease stipulations that require operators to avoid streams and minimize damage to riparian areas also benefited fish.

Other potential sources of fish habitat loss included exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Approximately 1,200 acres have been impacted by these sites in the past, and 740 acres of disturbance were still evident in 2001. Most of these sites were developed before 1977, thus their effects on the landscape have persisted for decades, and are likely to persist for several more.

Habitat Loss

Peat and gravel roads and pads, and gravel mines have caused the direct loss of fish habitat, and also led to the indirect loss of fish habitat due to erosion and sedimentation along streams and rivers, and alternation of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct over 9,200 acres of roads and pads, while gravel mines have impacted another 6,360 acres. Although much of this development would have occurred in upland areas, over 5,000 acres of mines were associated with streams and rivers (NRC 2003).

Drainage Patterns

Drainage patterns are altered by the construction of roads or pads in or across wetlands or drainage areas. To date, over 9,200 acres of gravel pads and roads, and over 600 miles of roadways, have been constructed in association with oil-field development on the North Slope. In addition to causing the loss of some fish habitat, much of the gravel fill has been in wetlands where cross-pad drainage has been blocked by road construction. During spring ice break-up, there is substantial flow across expansive wetlands into lakes and streams. When long stretches of gravel road or pad interrupt flow, the difference in water surface elevation from one side of the pad or road to the other can produce high-velocity water flow in the cross-pad/road drainage structures, usually culverts, which can inhibit upstream fish movements and delay migration to various summer habitats. The delays are particularly problematic for Arctic grayling, which spawn shortly after break-up and often undertake long, rapid migrations from wintering areas to spawning sites.

An opposite effect can occur in mid- to late summer when stream flow is low. Fish that disperse during or after break-up must leave small drainages and shallow lakes to reach wintering areas before those waters freeze because there are often limited or no opportunities for overwintering within the habitats used for summer feeding. Fish that cannot leave would freeze. An inadequate number or improper placing of culverts or modifications to the stream bed can cause flow to go below the surface or to be spread too shallow to allow downstream movement when flow levels are reduced in late summer.

Through 2001, nearly 1,400 culverts had been installed on the North Slope (NRC 2003). If not properly installed or sized, water flows can be affected or ice jams can form, impacting fish habitat. Typically, bridges are used where flows exceed 500 cfs, and 60-inch-diameter line pipes are proposed, instead of culverts, for the Alpine Satellite Development (USDOI BLM 2004c). If not correctly sized, engineered, or constructed, impacts to fish associated with bridges, pipes, and culverts would persist and accumulate.

Approximately 4,500 acres of gravel mines have been reclaimed, some to provide deepwater habitat for fish; much of the gravel was obtained from gravel deposits within floodplains. But concerns arising from this practice prompted the USFWS to study the effects of floodplain gravel mining on the floodplains physical and biotic processes (Woodward-Clyde Consultants 1980). The study identified numerous examples of habitat modification, including increased channel braiding, loss of wintering areas, spreading of flow, and restriction of fish movements, such as fish mortality caused by stranding. The study also set forth guidelines for gravel mining to minimize floodplain damage (Joyce et al. 1980). In response to agency concerns, and the results of the USFWS study, new gravel mines have primarily been sited in upland sites since the 1980s. Of the 5,080 acres of gravel mines sited in rivers, all but 350 acres were developed before 1973. One benefit of these pits is that they provide freshwater wintering habitat for fish. Since 1989, Arctic grayling have been stocked in several deep gravel pits that now provide fish habitat. According to the NRC (2003), the positive effects to fish from gravel pits likely outweigh the negative effects, and these effects persist today where gravel pits once were.

<u>Water Withdrawal</u>

Use of fresh water has increased in recent years because of expanded oil-field development and increased exploration. In the early years of exploration, water was obtained from any source, including rivers during winter. Bendock (1977 *in* Winters et al. 1988) documented water withdrawals from the Sagavanirktok River that depleted water in wintering areas and increased mortality to fish in the area. Much of the water needed in the established oil fields is now obtained from reservoirs that are replenished with runoff during spring ice breakup; most of the water used in exploration is from lakes.

Ice thickness has a great influence on the distribution of fish in lakes across the ACP. Most lakes in the existing development area between the Colville and Sagavanirktok rivers are less than 6 feet deep, few fish are present and effects have been minimal. As development spreads into regions with deeper lakes, such as the Colville River Delta and the eastern part the National Petroleum Reserve – Alaska, there is greater potential for having fish populations within lakes. Under current ADFG and BLM policies, water withdrawals from fish-bearing lakes are limited to 15 percent of the estimated minimum winter water volume. This policy was adopted to allow some water use, while preserving most of the water for wintering fish; the criterion was set arbitrarily because there were no data to support a different use. Fish populations in lakes subjected to this maximum allowable withdrawal appear to be unaffected, but data on consequences are limited, and there has been no research to determine the effects of withdrawals on populations of invertebrates in the lakes or on vertebrate food supplies.

The current practice for ice road construction is to permit withdrawals from a large number of lakes along a desired route, then to allow the ice road contractor to draw from the nearest suitable lake. This allows for maximum construction flexibility, but it complicates the tracking of withdrawal volumes: much more water is permitted for withdrawal than is used. Between 1998 and 2001, for example, Phillips Alaska obtained annual permits for withdrawals of more than 2.2 billion gallons, but used less than 240 million gallons in any given year.

An additional issue associated with water withdrawals from fish-bearing lakes is the potential to remove fish during pumping. In recent years, as construction of ice roads has increased in the vicinity of Nuiqsut, residents have reported finding fish frozen into the roads. Contracts issued for ice road construction specify that water is to be screened to avoid removing fish, but contractors sometimes failed to install screens. In some cases, sampling to identify the presence of fish before water withdrawal used gear that was not appropriate for detecting smaller species, such as ninespine stickleback and Alaska blackfish. The problem can be aggravated when lighted shacks are placed over the hole from which water is withdrawn. Thus, effects to fish from water withdrawals have accumulated, but have not adversely affected fish populations.

Causeways and Intake Pipes
Coastal development that poses the greatest risk of causing effects that accumulate in nearshore habitats includes facilities that change physical conditions that are important to nearshore biota. Such structures include causeways that modify water temperature and salinity.

Two major causeways have been built into the nearshore region to support oil-field activities. The Prudhoe Bay West Dock was built in the winter of 1974-1975, primarily to support off-loading of large modules used to develop the field; it was modified in 1981 to support the intake structure for the Prudhoe Bay waterflood facility to supply water needed for injection into the oil reservoirs. The causeway runs from the east end of Simpson Lagoon to the west entrance to Prudhoe Bay. The second major causeway, in the middle of the Sagavanirktok River Delta, was built to support facilities for the Endicott oilfield.

Accumulation of effects is a concern when multiple causeways affect the same fish population. The migratory stocks found along the Beaufort Sea coast are likely to encounter multiple causeways during their annual summer feeding movements. From the late 1970s to the late 1980s, there was substantial concern over the potential effects of the two long causeways to migrating fishes, especially for the integrity of the nearshore band of relatively warm, low salinity coastal water that is used by migrating fish Craig (1984). Causeways built perpendicular to shore disrupt the east-west flow of the coastal currents, and can alter fish movements within the band. Permits issued by the USACE and the NSB for causeway construction included lease stipulations for monitoring the effects of the causeway on fish movements and habitat, among other issues. Initial monitoring studied the West Dock Causeway between 1981 and 1984 and then the West Dock and Endicott causeways between 1985 and 1987. In 1988, the USACE concluded that although there were effects to fish, significant harm to habitat had been demonstrated and that further monitoring for effects on fish populations was not required (Hachmeister 1991). Those effects, as summarized by Ross (1988), included degradation of habitat quality in the nearshore region, alteration to fish movements and fish use of the Prudhoe Bay area, and changes to fish community structure.

The NSB’s program showed that the causeways, particularly the West Dock Causeway, interfered with the eastward movement of juvenile least ciscos and humpback whitefish moving from the Colville River into the Prudhoe Bay area during early summer (Moulton et al. 1986a; Fechhelm et al. 1989; Fechhelm 1999; Gallaway and Fechhelm 2000). Juvenile Dolly Varden might also be affected (Hachmeister et al. 1991). The movement of young-of-the-year Arctic cisco from the Mackenzie River into the Alaskan Beaufort Sea region did not appear to be affected by the causeways. Retrofitting of breaches in both causeways in 1994 and 1996 appeared to reduce the effect of the interference to least cisco and humpback whitefish migrations (Fechhelm 1999).

In addition to the causeways, large intake pipes are used to withdraw water from the nearshore region. The Prudhoe Bay waterflood facility, constructed in 1981, can supply 92.4 million gallons of seawater per day. There are also seawater intakes at Endicott (11.6 million gallons per day), and Kuparuk (25.2 million gallons per day). Monitoring of the intakes and marine bypass systems was conducted after start-up for the Prudhoe Bay and Kuparuk waterflood facilities from 1984 to 1987 to assess fish entrapment in intake structures (Dames and Moore 1985-1987). Fish were rarely observed during the monitoring studies, and most of those that entered the system passed successfully. However, approximately 1.5 million fish larvae of nine species were estimated to have been entrapped in the Prudhoe Bay facility in 1985. The intakes were judged to performing as designed, and monitoring was discontinued after 1987.

Spills. Overall, the effects of spills on fish have not accumulated on the North Slope because the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003).

Summary of Past Effects and Their Accumulation. Non-oil and gas activities, including development and subsistence and recreational fishing have impacted fish and their habitat, but these effects have been minor and have likely not had an effect on fish that persists today.

The energy produced by vibration equipment used to acquire seismic data has not been an issue because the vibrations are below threshold known to affect fish in streams and lakes crossed during seismic investigations.

Approximately 2,500 acres of direct impacts to uplands and wetlands from non-oil and gas activities persist today. Oil and gas activities have caused approximately 12,000 acres of direct impacts to uplands and wetlands that persist today; another 18,000 acres of indirect impacts have also occurred, some of which persist today and affect water bodies. These effects accumulate, but do not appear to have adversely affected fish populations on the North Slope. During the early years of development, gravel mining for roads and pads often interrupted both ice sheet flow and stream flows, and hence fish movement. The permitting process and the regulatory environment for protecting fish have improved over time and are generally effective. Proper construction and placement of bridges and culverts have greatly reduced effects but have not eliminated them; these effects have accumulated.

Little is known on the effects on fish of water withdrawals from lakes. Some fish have been harmed or killed during water extraction, but these numbers would be very small and would not accumulate. Existing causeways near Prudhoe Bay do not affect the westward recruitment of Arctic cisco into the Colville River and associated rearing areas. Blockage of young least cisco and whitefish moving eastward from Colville to Prudhoe Bay was demonstrated under certain wind conditions in some years at the West Dock causeway. This blockage was reduced by the breach retrofit installed in 1996. The effectiveness of breach design for existing or new causeways has not been resolved. Breaches arc effective, but there is more to be learned about the best or most appropriate design and placement of them. Seawater intakes have been designed to prevent entrapment of fishes. There is potential that the effects of causeways do accumulate for fish, although more studies are needed.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Some fish habitat would be lost due to growth of villages and from new developments on the North Slope. Subsistence and recreational fishing will continue to remove a small portion of the fish population. Although some of these effects would accumulate, their impact on fish populations would be minor.

Although not part of the development scenario for the Planning Area, it is reasonably foreseeable that the State of Alaska would build a new highway from the existing oil fields or the TAPS to the Planning Area. One proposal is to build a road from the Spine Road to Nuiqsut. Assuming a length of 18 miles (to connect the existing Spine Road to a proposed bridge at the Colville River) and assuming the same impacts for construction as for other gravel roads and pads, such a road would cover approximately 80 acres for the road and 20 acres would be lost from development of gravel mines. Another proposal is to build a road from TAPS to the Planning Area. This road could be 100 or more miles in length, and would directly impact 425 acres or morel. An additional 80 acres could be impacted due to development of gravel mines. These roads would likely cross numerous water bodies, and potentially several lakes. Thus, erosion associated with soil disturbance, and spills from equipment and construction activities, could impact fish habitat. In addition, if not properly engineered and installed, culverts and bridges could affect fish habitat and movements.

Other impacts from a new road would be related to added fishing pressure. Extending and opening the road to the public would increase public access from the Dalton Highway (assuming the state portion of the road is open to the public) to the Colville River for fishing and other recreational activities. There would be increased fishing pressure on, and harvest, from fish-bearing rivers that cross the road. Lakes in close proximity to the road would also receive increased fishing pressure. Species such as lake trout, Arctic grayling, northern pike, burbot, and Arctic char would be targeted. Since fish grow slowly in the Arctic, because of the harsh environmental conditions, fish are more susceptible to over-harvest. The effects of additional fishing pressure would have an effect on fish, but would not accumulate at the population level if management guidelines were implemented and fish harvest limits were enforced.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Concerns related to future habitat degradation from seismic train movement are minimal, given lease stipulations in the 1998 Northeast IAP/EIS ROD, those proposed in this Amended IAP/EIS (e.g., equipment operators would cross streams at shallow riffles), and state regulations. Fuel spills associated with seismic work would be expected to consist of small spills of refined fuel that would be unlikely to reach aquatic habitats. The effects of vibration on most overwintering fish should be minimal (short-term avoidance), given the low density of fish in most of the North Slope oil and gas exploration sites during the winter and the short time duration of vibration impulses in any given spot. As a result, increased seismic activity is unlikely to have a measurable effect on fish populations in the future.

Oil and Gas Production and Development

An estimated 4,000 acres could be disturbed from oil and gas development on the North Slope during the next 25 years (Table 4-37). An additional 4,000 acres could be impacted by 2050 if development occurs in the Northwest and South National Petroleum – Reserve. Given the high potential for oil near the coastline of the Planning Area and North Slope, it is likely that wetland would comprise 95 percent of more of the disturbance area, and some of this habitat would be used by fish.

Additional construction outside of the Planning Area necessary to support oil and gas exploration and development in the Planning Area would include an increased number of ice roads and new pipelines. Potential impacts to fish both within and beyond the Planning Area boundaries would be related to water withdrawal and direct habitat loss or indirect disturbance associated with construction of a pipeline. Increased water use, in and of itself, would not necessarily increase impacts to fish species. Effects would be dependent on the location of withdrawal and amount of water used. Assuming that water withdrawals outside the Planning Area would also be limited to 15 percent of the free water volume from lakes that do not freeze solid, impacts to fish would likely limited to localized, short-term, population abundance and distribution changes. Impacts from pipeline construction and the accompanying gravel extraction, with its resultant erosion and sedimentation, would be similar to those described under the action alternatives. Though dependent on the actual level and location of implementation, the increase in the overall effect of construction-related activities in the cumulative case would accumulate, but would have a minor affect on fish populations.

Spills

The cumulative case involves the potential for more oil spills. Many of the projects considered in the cumulative case would be conducted outside of the Planning Area. The additional oil spills associated with some of these projects could affect the migratory and marine fish that use the coastal areas. Offshore oil spills, or those that occur in rivers and move into coastal waters, would be likely to increase oil-related effects on Arctic fish. Cumulative effects would depend on the number, size, and seasonal timing of the spills, concentrations of hydrocarbons, and the life stages of fish exposed to the spills. Lethal effects on fish from oil spills are seldom observed outside of the laboratory environment. For this reason, oil spills are expected to have mostly sublethal effects on the fish affected by them. For example, displacement from oiled water may lead to increased energy expenditures while foraging, with subsequent reduction in growth and reproduction. Juvenile fish that are common in the nearshore area during summer, migratory fish, and nearshore spawners would be among those most likely to experience lethal or sublethal effects. Because in the cumulative case there would be a greater probability of an oil spill contacting coastal waters, it is likely that a greater percentage of fish would be affected. Land-based, cumulative-case oil spills that did not enter coastal waters would be expected to have minor effects on overall fish populations, since the likelihood of a large spill contacting water would be minor. Losses onshore would be greatest in water bodies with limited water exchange.

Abandonment

To date, very little abandonment (except for single exploration or development wells) has occurred anywhere on the North Slope. Restoration of other types of facilities, such as gravel extraction sites and older exploration pads, has taken place at a small scale at several locations on state lands on the North Slope outside of the Planning Area

(Jorgenson et al 1992; McKendrick et al 1992; Herlugson et al 1996; McKendrick 1996). These restoration efforts are being closely monitored in an effort to determine the most appropriate and effective methods for restoration.

As with roads, abandonment of bridges and culverts would occur once the economic life of the oil fields had passed. Because the bridges and culverts are an integral portion of the proposed road network, the fate of the bridges would likely be determined by the fate of the road network. If roads were left in place, but not with the intention that they be maintained for continued use, culverts could be removed and the gravel pads breached to facilitate water flow. If culverts, bridges, or pipes were left in place at abandonment, there is potential that these structures would deteriorate and become clogged, inhibiting water flow and fish passage. If this occurred, the effects to fish would accumulate and persist indefinitely.

Open-pit gravel mine rehabilitation typically involves converting mine sites to lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats.

Global Climate Change

Ice cover in the Arctic Ocean has been shrinking about 3 percent per decade during the past 2 decades (Johannessen et al. 1999). If this trend continues, the sea ice would disappear entirely during the summer in about 50 years. Some species of fish would benefit from this trend, especially those that reside in warmer waters, while cold-water species would be forced further north. These effects would accumulate, but the adverse effects to species in decline could be compensated for, to some degree, by reducing the commercial fish harvest of these species. Shifts in species and their numbers could affect subsistence harvests on the North Slope.

Contribution of Amendment Alternatives to Cumulative Effects

Seismic activities could disturb up to 250,000 acres of soil under the action alternatives. The number of acres disturbed annually would be similar to the amount of acreage that has been disturbed annually by seismic surveys during the past decade in the Planning Area. It is assumed that seismic train moves would originate from Kuparuk and traverse about 30 miles east of the Planning Area in each direction. However, much of this distance would be along an ice road that is built annually from Kuparuk to the Alpine oil field, limiting most impacts of the seismic train outside of the Planning Area to the minor impacts associated with ice roads. Nonetheless, impacts associated with seismic operations, including water withdrawals to make ice roads, occurring in the Northeast National Petroleum Reserve – Alaska would be additive with impacts from seismic operations in other portions of the National Petroleum Reserve – Alaska and across the North Slope.

If oil prices average $25 per bbl, development in the Planning Area would directly impact 300, 1,120, 1,380, and 920 acres for alternatives A through D, respectively, and indirectly impact 400 to 2,400 acres (1,600 acres under the final Preferred Alternative). If development occurred in the northern portion of the Planning Area, 95 percent or more of the impacted area would likely be wetland, and a portion would be fish habitat. The loss of fish habitat would persist. Impacts associated with the Planning Area would be additive to past, present, and reasonably foreseeable future soil impacts on the North Slope. If global climate change persists, the effects to fish could be much greater than predicted, although some species are expected to benefit from global climate change. A portion of the disturbance area would be for gravel extraction (approximately 20 to 300 acres; 140 acres for the final Preferred Alternative at an oil price of $25/bbl). Although the current emphasis is to extract gravel from upland sites, it could still be possible to create potential overwintering habitat at these sites when abandoned.

Conclusion

Wide-ranging increased impacts to Arctic fish populations found on the North Slope would not be anticipated based on the cumulative analysis, but some effects to fish described above would accumulate. Localized changes to fish populations in the vicinity of a road connecting to the Dalton Highway would be possible. Synergistic impacts to fish from disturbance related to oil and gas production under any of the alternatives in this amendment are not anticipated. Beneficial effects related to material extraction at gravel sites would be possible in certain situations.

Past reclamation of deep pits that have been mined has proved beneficial when new habitat for Arctic fish species has been established. If oil and gas activities occurred in areas with high fish populations, or use by sensitive or important subsistence species, impacts to fish could be greater than impacts predicted based on the amount of area impacted.

4.7.7.8 Birds

About 80 species of birds occur in the Planning Area, and the North Slope provides habitat for millions of birds each year. Primary factors that limit avian populations are habitat loss, disturbances that displace birds from preferred habitat areas, hunting, and predation. An oil spill could cause the direct mortality to birds due to its toxic effects, and indirectly affect habitat. Global climate change is of concern because it may cause shifts in available habitat types, and a concurrent shift in the bird species that use these habitats. Oil and gas exploration and development in the Planning Area are the primary contributing activities in terms of cumulative effects on birds on the North Slope. Other factors that contribute to the cumulative loss of birds include permitted activities such as non-oil and gas overland moves and development, scientific data gathering, and recreational use by the public. In addition, any analysis of cumulative effects to birds must include effects to birds on migration and wintering areas, where impacts to birds could be independent of activities on the North Slope. Because bird populations can show substantial changes among years, it is often difficult to determine if effects are accumulating at the population level, or merely reflect short-term shifts in population numbers.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities that occur on the North Slope and are not directly related to oil and gas development can add to the cumulative impacts to birds. Activities include wildlife research and survey activities, recreation activities, village expansion, spills and other environmental contamination, predation, and subsistence harvest. These impacts are usually localized and would generally affect only small numbers of birds and would not accumulate at the population level.

Research and Survey Activities. Various types of disturbances affect tundra-nesting birds near summer camps. Noise and ground activities disturb feeding, nesting, or brood-rearing birds, causing temporary or permanent displacement from feeding or nesting areas potentially affecting energy budgets and productivity. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some birds have acclimated to predictable daily activities of camp personnel. Disturbance to birds from aircraft traffic and camp activities is greatest within approximately 2,280 feet of the camps and little or no effect beyond 6,500 feet (Johnson et al. 2003b). Ward et al. (1999) also studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. The greatest response to aircraft altitude occurred between 1,000 and 2,500 feet. Tundra-nesting birds near summer camps could suffer mortality or egg loss due to predators attracted to anthropogenic sources of food at camps.

Summer boat traffic occurs on the Colville, Kogosukruk, Kikiakrorak, and Ikpikpuk rivers for recreational or subsistence activities, or to re-supply camps along these rivers. Numerous studies have reported on the effects of boat disturbance to birds (McGarigal et al. 1991; Steidl and Anthony 1996); this activity could potentially affect nesting gyrfalcons, peregrine falcons, and rough-legged hawks in the Colville River Raptor, Passerine, and Moose LUEA and the Ikpikpuk River area. The current levels of boat activities on these rivers have apparently not impacted raptors negatively, as some populations, particularly the peregrine falcon, have been increasing on the ACP in recent years (Ritchie and Wildman 2000).

Aerial surveys for wildlife and to mobilize and re-supply summer camps in the Planning Area could include fixed-wing aircraft surveys for waterfowl and caribou, or helicopter surveys for tagging and subsequent radio-tracking of grizzly bears or caribou. Low-level fixed-wing aerial surveys likely had little effect on birds given the short amount of time aircraft would be in a particular area. Ward et al. (1999) reported a decreasing level of response to aircraft overflights by brant with increased lateral distance of aircraft. Additionally, pedestrian traffic has been shown to be more disruptive to some waterfowl species than other types of disturbance (Johnson et al. 2003b). The effects to birds from these activities have ranged from temporary displacement from preferred feeding habitats to nest abandonment and loss of production for the breeding season. These effects would be minor and likely would not accumulate at the population level.

Development. Non-oil and gas development at former military sites and in villages has caused the loss of habitat and increased levels of disturbance. These sites also provide a potential starting point for hunting trips. Approximately 2,500 acres have been disturbed, with most of the development along the coastline where large numbers of birds are found. Although there is limited information on historic numbers of birds found in these areas, the population density of some species, including Pacific loons, tundra swans, pintails, and long-tailed ducks is moderately high to high near Barrow and Nuiqsut. Development and loss of habitat and disturbance, coupled with hunting pressure at "Duck Camp" near Barrow, and other recreational and subsistence hunting near other villages, would cause the loss of birds and habitat that would accumulate.

Subsistence. Migratory birds, particularly eider ducks and geese, are an important food source for villages on the North Slope. Bird eggs are also gathered. Waterfowl are hunted during the spring whaling season, during late spring and early summer, and during early fall. In earlier times, Iñupiat resource users harvested flightless molted birds by cooperatively herding them into creeks, and dividing the harvest between the work group members. One resident remembered doing this cooperative herding as recently as the late 1940s at Oliktok Point. In the past, Nuiqsut people gathered and stored eggs from waterfowl nests on the tundra. According to 2003 interviews, eggs are no longer gathered, and certain species of waterfowl are not harvested. Some residents indicated that they do not eat certain varieties of ducks (e.g. oldsquaws and pintails), while many choose to avoid harvesting black brant and spectacled eiders because they are threatened or species of concern.

Barrow residents harvested about 8,000 pounds of waterfowl annually from 1962 to 1982, and 20,000 to 30,000 pounds of waterfowl annually during the late 1980s and early 1990s; waterfowl accounted for about 4 percent of the subsistence harvest (see Appendix J). Atqasuk hunters harvest migratory birds, especially white-fronted geese, during spring through fall. Bird harvests amount to a few hundred pounds per year, and about 3 percent of the subsistence harvest. Nuiqsut residents harvest about 3,000 to 8,000 pounds of waterfowl and their eggs annually, about 5 percent of the subsistence harvest. Much of the harvest occurs along Fish and Judy creeks. Birds and their eggs comprise less than 2 percent of the subsistence diet of Anaktuvuk Pass residents. Subsistence hunting, especially egg gathering and goose herding, has the potential to adversely impact local populations of waterfowl, although the number of birds harvested would be negligible in the context of the continent-wide harvest.

Oil and Gas Exploration and Development Activities

Seismic Activity and Exploration. The two primary factors associated with seismic activities and exploration that could affect birds on the North Slope are loss of habitat and disturbance. Most seismic surveys and exploration drilling activities occur during the winter months when most birds are not present in the Planning Area. Therefore, these activities would have no direct impacts that would accumulate for most species. A few species, including snowy owl, gyrfalcon, ptarmigan, and common raven, which may be present in the Planning Area during winter, could be temporarily displaced from preferred feeding areas by oil and gas exploration activities. Given that these activities occurred within only a small portion of the North Slope, it is unlikely that these effects have accumulated.

The use of airguns for boat-based seismic work in Teshekpuk Lake likely displaced loons and waterfowl from preferred feeding habitats while surveys were being conducted. However, these surveys have only occurred a few times in the past, and it is unlikely that effects to birds have accumulated.

Seismic surveys have been conducted over most of the North Slope since the 1940s. Rolligons and track vehicles used during seismic exploration have left tracks on tundra habitats, but less than 100 acres of habitat has scars persisting today that could result in habitat loss for birds. Wet areas are less likely to be affected than dry areas (Walker 1996). Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still in evidence 8 years later, but that 5 percent of camp-move trails still showed moderate to high disturbance. Use of lightweight vehicles, dispersing traffic patterns, minimizing sharp turns, and requiring surveys to be done when snow and frost cover is adequate to protect the tundra have helped to minimize damage to vegetation used by birds (Walker 1996).

Other sources of vegetative loss include gravel pads, airstrips, roads and disturbances near gravel structures at exploration sites. Peat roads that were constructed in the 1960s also caused disturbances to tundra habitats that persist today. However, some evidence suggests that bird use of peat roads is similar to that of adjacent areas of undisturbed tundra (TERA 1991). Based on NRC (2003), in 2001, approximately 1,200 acres had been impacted by exploration sites in the past, and 740 acres of disturbance were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more. As industry has shifted towards use of ice roads and ice pads during exploration, loss of habitat has slowed greatly.

Water used in the construction of ice roads and pads would be withdrawn from deep lakes in areas adjacent to the road and pad locations. Winter water withdrawal could alter lake levels and adjacent birds habitats, although flooding and recharge during spring break-up would likely minimize the potential for long-term effects (Rovansek et al. 1996). Since use of lakes in the past has varied, and few lakes would have had water withdrawn over several years, it seems unlikely that the effects of past use of lakes for water withdrawals would accumulate.

Infrastructure and Road and Pad Construction. Effects to birds habitat from road and pad construction and gravel mining, and disturbance associated with development and production activities, have occurred in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused the direct loss of avian habitat, and also have led to the indirect loss of habitat from the effects of road dust and alteration of natural drainage patterns. Although over 500 acres of peat roads still show evidence of disturbance, it is not clear that this disturbance has resulted in negative impacts to birds. Gravel footprints have impacted over 9,200 acres, while gravel mines have impacted another 6,360 acres of vegetation. Of this, all but 70 acres of gravel footprint persisted in 2001, but over 4,500 acres of gravel mines were reclaimed. Loss of habitat has accumulated and could limit local bird populations.

The passage of vehicle traffic over gravel pads and roads results in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel can smother vegetation. Based on assumptions used in this amendment, approximately 30 acres of vegetation could be impacted by dust for each 100 acres of development in the Planning Area, suggesting that 2,700 acres of bird habitat may be indirectly affected by existing gravel roads and pads on the North Slope. These impacts are likely to persist as long as vehicle travel occurs on the pads and roads.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near these structures by changing natural drainage patterns and areas where snow accumulates. These changes alter the species composition of the plant community near gravel structures and adversely affect birds. However, impoundments created by road and pad construction and dust deposition have created new feeding and brood-rearing habitat that has been beneficial to some bird species. Noel et al. (1996) reported that the areas occupied by impoundments in the Prudhoe Bay area generally supported higher waterfowl densities than the same areas did prior to development. Kertell (1993, 1994) reported few differences in invertebrate numbers and numbers of Pacific loons when comparing use of natural ponds and impoundments in the Prudhoe Bay area. He also reported that ducks were more abundant on impoundments than natural ponds, although this difference was not statistically significant. These effects, both beneficial and adverse, persist today on approximately 18,000 acres of vegetation on the North Slope.

Disturbance. Numerous types of disturbances could result from oil and gas exploration, development, and production activities, including those caused by aircraft, vehicular, pedestrian, and vessel traffic, construction and drilling activities, noise and activity at facilities, and predator attraction. Some level of disturbance to birds from these activities would be unavoidable. Impacts have been most prevalent where facilities were located in habitats with high bird concentrations.

Disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989, Derksen et al. 1992; McKechnie and Gladwin 1993; Ward et al 1999). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in the Arctic at the Alpine field. Responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. However, an avian monitoring study at the Alpine field showed that successful white-fronted goose nests were generally closer to the Alpine field airstrip, the flight path, and the nearest gravel source than unsuccessful nests, although most comparisons were not substantially different. Johnson et al. (2003b) also reported on tundra swans and yellow-billed loons nesting in proximity to the Alpine field airstrip. Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic.

During post-breeding studies in southwest Alaska, Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. Brant did not habituate to the overflights, and temporary displacement from preferred feeding, brood-rearing, or molting habitats could affect energy budgets of some birds, and incubating birds could be temporarily displaced from nests. These effects may have had short-term impacts to brant and other waterfowl, but impacts to local populations were minor.

Predators. Predators such as glaucous gulls, Arctic foxes, ravens, and grizzly bears could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment, which may cause increased predation pressure on tundra-nesting birds. There is evidence that nesting success for several species of ground-nesting birds may be lower in oil fields than in undeveloped areas (Troy 1996; Anderson et al. 2000; Sedinger and Stickney 2000). Sedinger and Stickney (2000) attributed low brant nest success in oil fields to high predator populations. Johnson (2000) noted a similar relationship for snow geese in some years. Despite the poor production rates, snow goose and brant numbers have increased in oil fields since the early 1980s. Thus, effects of development to snow geese and brant are accumulating, although it is not entirely clear if oil field development has had an adverse (poor reproductive success) or positive (increased population size and growth rates) effect. Impacts to brant and snow geese on the North Slope may be the result of factors outside the breeding and molting grounds.

Increases in the number of predators in areas of development could have an additive impact on the effects of predation on bird populations, particularly for species with low or declining populations or species of special concern such as yellow-billed loon, long-tailed duck, and buff-breasted sandpiper. In recent years, North Slope oil field developers have installed predator-proof dumpsters to minimize attraction of predators to development. This policy has apparently been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of predator species, other than the common raven, after development.

Collisions. Bird mortality has resulted from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development. Offshore activities are most likely to impact birds during the late summer/fall staging period, when relatively large numbers of loons, long-tailed ducks, eiders, and other waterfowl are staging and molting in marine areas. Migration pathways may include areas where offshore production facilities are constructed, so collisions with offshore structures, and with vessel and helicopter traffic used for transport of personnel and equipment or responding to an oil spill, could occur. Bird collisions with vehicles, buildings or oil field infrastructure probably do not represent a significant source of bird mortality at the population level. However, bird losses due to collisions in developed areas accumulate with increases in development and add incrementally to other impacts.

Spills. No large oil spills have occurred on the North Slope. Small spills have occurred but cleanup and rehabilitation efforts have been successful and relatively few birds have been impacted (NRC 2003). The cumulative effects of oil spills on the North Slope have added only incrementally to impacts on birds.

Marine Activities. Offshore oil exploration and development, which occurs in both state and federal offshore marine waters of the North Slope, rely on helicopter and barge traffic more often than on fixed-wing flights. Most of this activity occurs during the winter when birds are not present. However, helicopter activity, barge and crew vessel traffic, and spill response training activities do occur during the summer. During the summer open-water seasons of 2001 and 2002 at the Northstar development off Prudhoe Bay, helicopter activity ranged from 477 to 989 round trips, crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips (Williams 2002, Williams and Rodrigues 2003). Vessel traffic not related to oil development also occurs in marine waters off the coast of the North Slope. These activities have displaced marine birds in the past, but it is unlikely that effects have accumulated.

Factors Outside of the North Slope

Numerous factors could affect birds at various locations around the world. Various types of contaminants and toxins from industrial and agricultural activities can enter either terrestrial or marine environments and affect bird mortality or reproductive success. Oil spills have been an obvious source of bird mortality at numerous locations around the world. Commercial fishing activities have caused changes in predator-prey relationships that could affect wintering loons and waterfowl that feed in offshore marine habitats. Marine birds could also become entangled in fishing gear currently being used in commercial fishing activities or in abandoned gear that persists in marine environments. Many waterfowl species are hunted for sport during the fall migration and on the wintering grounds. Subsistence users take waterfowl or other bird species during spring and fall hunts, as well as eggs during the nesting season. There is evidence that contamination of feeding habitat with spent lead shot may result in lead poisoning of waterfowl in some areas including the Y-K delta. Development along migration corridors and in wintering areas may result in habitat loss or disturbance that add to the cumulative impacts on bird populations. All of these factors can add to the cumulative loss of individual birds, and in some instances, can have population-level effects.

Summary of Past Impacts and Their Accumulation

Approximately 2,500 acres of direct impacts, and about 5,000 acres of indirect impacts to bird habitat from non-oil and gas activities persist today. Oil and gas activities have directly impacted approximately 13,000 acres of bird habitat, and indirectly impacted approximately 21,000 acres of habitat that persist today. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial developments, and oil and gas activities, these impacts to habitat are additive to future impacts and would be likely to persist for several decades or more, in the absence of an active reclamation program. The impacts of predators on bird populations may be slowly waning as industry reduces the amount of predator-attracting garbage in the fields. Other effects, including disturbance, are difficult to measure, but are likely accumulating as the number of developments and the amount of developed area increase. The typical gravel pad and amount of roadway needed to service a development have become smaller over time, reducing the amount of bird habitat lost due to development as compared to past levels. However, new development often relies on aircraft support for transportation of personnel and equipment that can increase disturbance to feeding, nesting, and molting birds. Habitat loss and disturbance can add incrementally to the impacts of development on birds.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs, such as four-wheel vehicles and snowmachines, would continue to result in the loss of minor amounts of bird habitat and cause disturbance to birds. In most cases, loss of habitat would be temporary, lasting only a few years. DEW-Line sites and other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future. Villages are likely to increase in size, causing the loss of additional habitat.

Although not part of the development scenario for the Planning Area, it is reasonably foreseeable that the State of Alaska would build a new highway from the existing oil fields or the TAPS to the Planning Area. One proposal is to build a road from the Spine Road to Nuiqsut. Assuming a length of 18 miles (to connect the existing Spine Road to a proposed bridge at the Colville River) and assuming the same impacts for construction as for other gravel roads and pads, such a road would cover approximately 80 acres for the road and 20 acres would be lost as bird habitat from development of gravel mines. Another proposal is to build a road from TAPS to the Planning Area. This road could be 100 or more miles in length, and would directly impact 425 acres or more. An additional 80 acres could be impacted due to development of gravel mines. Erosion associated with soil disturbance, and spills from equipment and construction activities, could impact bird habitat. The road may increase the number of visitors and hunters to the Planning Area, resulting in increased disturbance and hunting pressure to birds.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. About 1,300 miles of seismic trails are expected to be added each year. Based on previous seismic exploration activity, this activity could impact up to 100 acres of habitat annually, with moderate to high levels of disturbance continuing a decade later. However, with the use of newer seismic technology, it is likely that impacts to vegetation that persist for a decade or more would be substantially less than this estimate (Jorgenson et al. 2003).

Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, and airstrips and gravel roads at exploration sites. In recent years, gravel structures for exploration activity have been replaced by ice roads, airstrips, and drilling pads to reduce costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, the long-term effects of exploration activities are likely to affect only a small amount of habitat, although effects would accumulate.

Oil and Gas Roads and Infrastructure. Future development activities in the northwestern and southern portions of the National Petroleum Reserve – Alaska, federal and state offshore oil development (through the construction of supporting onshore infrastructure), state onshore oil development, and oil transportation could contribute to cumulative impacts on birds. All of these activities involve construction of infrastructure that would destroy habitat within the immediate footprint of the project, and indirectly affect bird habitat through dust deposition, changes in natural drainage patterns, thermokarst, and snow drifting.

Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, it is estimated that an additional 3,500 acres would be covered by gravel, and 500 acres impacted by gravel mines, in the next 25 years, much of this in the Planning Area. Approximately 9,200 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. An additional 4,000 acres of bird habitat could be directly impacted by oil and gas activities between 2030 and 2055; another 9,200 acres would be indirectly impacted by development.

These impacts are additive to the impacts to vegetation that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct (21,000 acres) and indirect (36,000 acres) impacts that could still persist in 2050, direct and indirect impacts to bird habitat from activities on the North Slope would impact approximately 0.43 percent of the ACP and 0.10 percent of the North Slope. These estimates do not take into account the quality of habitat that would be impacted on the North Slope. However, it is likely that the focus of future oil and gas exploration and development would be within the Barrow Arch, which is located in the ACP. Highest population densities of many species of waterfowl and shorebirds are also found in this area; thus, impacts to birds from development would likely be much greater than if estimates of impacts are based solely on size of the facility footprint.

Disturbance. It is reasonable to assume that with increased development would come increased disturbance to birds. Although there is no clear indication that disturbance effects have accumulated to the point that they are adversely affecting bird populations, the effects of future developments would be additive to effects of present and past development. If birds are displaced from prime habitat by loss of habitat to gravel infrastructure, and disturbance further displaces birds, the effects of displacement and disturbance could result in energetic costs that reduce survival and productivity. These losses of individual birds would accumulate, and could persist as long as development occurred on the North Slope.

Predators. During the early years of oil field development, it is likely that predators were attracted to development by anthropogenic sources of food and shelter. Based on policies implemented by the BLM and private industry to discourage attraction of predators to areas of development, the effects of predators on birds are likely to stabilize or decrease over time. This policy has been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of most predator species, except ravens, after development.

Collisions. Bird mortality from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development is likely to persist into the future, and may increase with increasing levels of development. However, industry has implemented practices, including providing better lighting of facilities, burying power lines, and attaching power lines to pipelines, in an attempt to reduce the number of bird collisions oil and gas infrastructure. Losses from collisions are predicted to be small and would not adversely affect bird populations.

Spills. The oil industry is required to have oil spill response and clean-up capabilities, and small spills on lands or waters in the Planning Area or in existing or future North Slope oil fields are expected to be contained and cleaned up before substantial bird loss can occur. In addition to mortality through direct contact with oil, some mortality could result through ingestion of contaminants in food and water, and from the cumulative effects of the numerous small spills expected from the operation of any oil field.

A large onshore spill released in the Planning Area during the summer season could affect loons, waterfowl, shorebirds, and other bird groups. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for bird use, and oil entering freshwater aquatic habitats could spread more widely, potentially entering river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers should birds come in contact with oil, or from ingestion of contaminated prey. Oil that came in contact with eggs, either directly or through contact with partially oiled feathers of incubating adults, could negatively impact embryonic development. These effects would be additive to the effects of a spill in the existing North Slope oil fields, or to the effects of potential future spills that could occur in the Northwest and South National Petroleum Reserve – Alaska, if these areas were developed.

If future oil field development were to occur in state or federal marine waters offshore of the Planning Area, there would be a minor probability of a large oil spill. If one or more spills were to occur, substantial losses to loons and waterfowl could result if oil were released during the summer/fall season when large flocks of these birds were present. Large numbers of molting waterfowl are known to use the lagoon systems in offshore areas of the Beaufort and Chukchi seas. Thousands of molting or staging loons and waterfowl could be impacted by an offshore spill occurring in areas of high bird use, such as the lagoon system near Prudhoe Bay in the central Beaufort Sea or in Kasegaluk Lagoon in the Chukchi Sea. An offshore spill could also affect feeding habitats in littoral habitats, such as extensive mudflats in the Colville River Delta, which are used by staging shorebirds. The Colville River delta supports thousands of postbreeding shorebirds, the most abundant of which is dunlin (Andres 1994). The *arcticola* subspecies of dunlin is considered to be highly imperiled (Brown et al. 2001). An oil spill could also contaminate prey populations in foraging areas at any time of year, which could result in secondary impacts to loons, waterfowl, and shorebirds by affecting productivity and/or survival.

Tanker spills of crude oil from oil fields in the Planning Area could impact birds in marine habitats along the entire tanker route from the port at Valdez to West Coast refineries. A large oil spill in the Prince William Sound area, similar to the Exxon Valdez spill in 1989, would impact many thousands of waterfowl and marine birds at any time of the year. Large numbers of loons and waterfowl use Prince William Sound as a migratory stopover or wintering area. The Copper River Delta is a migratory stopover area for millions of shorebirds during spring and fall migration; if an oil spill were to spread to this area, it could impact many thousands of birds. Marine birds and waterfowl could also be impacted by an oil spill in the Gulf of Alaska or in open water or bay habitats along the

Pacific Coast of Canada, Washington, Oregon, and California. Oil spills occurring in coastal areas would likely produce greater impacts to birds than a spill occurring several hundred miles offshore, where bird densities are much lower. Spills, such as the Exxon Valdez spill and many smaller spills, have already caused extensive bird mortality in many of these areas. The actual numbers of birds impacted by an oil spill is likely much higher than the number of oiled carcasses recovered, because the carcasses of many oiled birds may never be recovered. The length of time required for populations to recover and the lingering effects of contamination varies among species.

Oil produced as a result of development in the Planning Area would contribute to less than 13 percent of future spills from TAPS, but would increase the number of onshore oil spills and would likely impact tundra systems in some instances. The amount of oil produced on the North Slope under the reasonably foreseeable future scenario is likely to continue to trend downward. As oil production slows, coupled with improvement in spill prevention and control technologies and training, effects to birds should decline over time.

Marine Activities. Offshore oil exploration and development is likely to slowly trend downward, reducing the risks to birds from offshore development over time. However, development near the coastline in the National Petroleum Reserve – Alaska and elsewhere on the North Slope would cause increased vessel traffic in the Beaufort Sea. Global climate change could increase the duration of the open-water period and vessel traffic could occur in the region for longer periods of time each year. As a result, effects to birds from vessel traffic and disturbance is likely to persist near current levels into the foreseeable future, and may even increase. This traffic could impact bird habitat use and behavior and cause the death or injury to some individuals, and impact energy budgets and the ability of some birds to store fat prior to migration.

Abandonment. The impacts of abandonment and rehabilitation of oil fields on birds would be similar in many respects to those incurred by construction activity. Activities occurring in the winter would cause little disturbance or displacement, because most species would be absent from the area. However, the melting of ice roads could be delayed, compared to surrounding tundra, causing impoundments of water. Delay in the melting of ice roads, compared to the surrounding tundra, could also cause either complete loss of nesting habitat for a season or compaction of vegetation, which would reduce the quality of the nesting habitat for a nesting season. Such impacts would only affect nesting in the summer following ice road use, and would be minor. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to birds that would be similar to, and at the same levels as that caused by traffic during construction and operations. If pads, roads, and airstrips were not revegetated, their value to birds would be lessened. If they were revegetated without removing the gravel, the habitat would not return to its current utility for most birds of the area. If gravel was removed, habitat similar to that currently existing in the area could be created and used by birds, though the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. The effects of habitat loss would accumulate, as described above, to the extent that habitats were not, or could not be, restored to their original condition.

Other Factors on the North Slope

Numerous other factors could add to cumulative impacts on bird populations. Subsistence harvest of waterfowl and their eggs continues to impact these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in waterfowl foraging habitat in the Y-K Delta may be impacting waterfowl survival. Although the proposed development scenario does not include a road to connect Nuiqsut with roads in the Planning Area, future construction of such a road could allow access that would increase subsistence hunting pressure on waterfowl, and increase the potential for lead shot contamination in feeding habitats. It is currently illegal to use lead shot while hunting waterfowl, although lead shot is allowed for hunting upland species. Illegal use of lead shot for hunting waterfowl, or legal use of lead shot for hunting upland species near waterfowl habitats, could contribute to the effects of lead poisoning on waterfowl populations.

Factors Outside of the North Slope

Wintering grounds and portions of migratory routes of many bird species lie in areas outside of the U.S., and regulated or non-regulated development in these areas can impact critical bird habitats. Habitat losses in non-breeding areas could be particularly significant for species of concern or species with low population numbers, such as buff-breasted sandpiper. Habitat losses may occur directly from habitat destruction due to development, or from pollution, such as exposure to agricultural pesticides that may reduce the ability of birds to reproduce or may cause direct mortality to birds. Other activities, such as commercial fishing, may also have the potential to cause changes in predator/prey relationships or damage benthic habitats that could affect some marine bird populations. Impacts related to subsistence hunting and sport hunting in wintering areas and along migratory routes can be additive to the effects of development on the North Slope. Spent lead shot that remains in waterfowl feeding habitat has been linked to lead poisoning for some waterfowl species (Franson et al. 1998). Impacts of subsistence hunting may impact species of concern such as brant, bar-tailed godwit, and threatened eiders as well as many more abundant species. Cumulative effects to birds would include habitat loss and disturbance related to activities on the migration and wintering grounds that could result in permanent or temporary displacement from preferred feeding and roosting habitats.

Global Climate Change

Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2004). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice. A few bird species, such as black guillemot that feed near the ice edge, may not be able to bring food to their young as the pack ice moves further offshore.

The increasing thickness of the active layer of soil above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Thawing of the permafrost may result in increased amounts of surface water in some areas. Areas of permafrost with substrates composed of fine-grained materials may be susceptible to drying, erosion, and desertification (ACIA 2004). Rising temperatures are likely to favor the expansion of the northern boreal forest into areas currently occupied by tundra. Global climate change may also result in an increase in shrubs at the expense of forbs and graminoid vegetation characteristic of Arctic tundra. In addition, rising seal levels resulting from increasing temperatures may further reduces the amount of tundra habitat available to nesting birds by causing coastal erosion and by inundating low-lying areas. These changes may be beneficial to some species such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact tundra-nesting shorebirds and waterfowl.

Contribution of Amendment Alternatives to Cumulative Effects

Impacts to habitat from seismic surveys in the Planning Area would occur on approximately 150 (Alternative A) to 200 (alternatives B, C, and D) acres. Impacts from ice road construction would occur on another 210 acres annually, while impacts from ice pads would occur on 30 to 270 acres during the life of the project; these impacts to habitat would be short-term and would not accumulate.

Development in the Planning Area would directly and indirectly impact 790, 3,480, 4,210, and 2,810 acres of bird habitat for alternatives A through D, respectively, if oil prices average $25/bbl. Wetlands, which are important to waterfowl and shorebirds, would comprise approximately 95 percent of this habitat loss. These habitat losses could account for 3 to 14 percent of the habitat projected to be lost due to development on the North Slope during the next 50 years. Given that the area most likely to developed under the action alternatives is located north and northeast of Teshekpuk Lake, areas that support large numbers of waterfowl and shorebirds, impacts to birds could be much greater than predicted based on amount of area disturbed. As shown on Maps 3-13, 3-14, 3-15, 3-16, 3-17, 3-18, and 3-19, the area to the north, northeast, and east of Teshekpuk Lake and to the coastline has medium to high population densities of several species of waterfowl, and shorebirds, including white-fronted geese, brant, and pintails. Depending on the types and locations of facilities, impacts to brant and other waterfowl could accumulate, especially where species are concentrated, and affect the long-term health of local populations. The effects to waterfowl, shorebirds, and other birds from oil and gas development would be less under the No Action Alternative and Alternative B, because all (No Action Alternative) or most (Alternative B) of this area would be closed to leasing under these alternatives. The effects would be greatest under Alternative C, since the entire area would be open to leasing. The effects from the final Preferred Alternative would be less than Alternative C, but greater than Alternative B, since some development could occur within this area.

Conclusion

Birds are not distributed evenly across the Planning Area and some areas and habitats are more important to some species than others. Areas northeast and northwest of Teshekpuk appear to be areas with high densities of nesting shorebirds, and the Goose Molting Area north of Teshekpuk Lake is extremely important for brant and other molting geese. If these areas were developed, impacts to birds could be greater than those predicted based on amount of disturbance area in the overall Planning Area.

Potential future oil and gas leasing, exploration, and development activities would be the major source of cumulative effects to birds that could occur in the Planning Area. These effects would be additive to the effects of activities that have occurred in the past on the North Slope, along migratory routes, and in wintering areas. These include all of the activities related to oil and gas development in existing fields east of the Planning Area, and potential future oil and gas leasing and development in North Slope areas west of the Planning Area. The effects of global climate change are difficult to predict, but changes in habitat structure associated with climate change would likely have a cumulative impact on bird populations.

4.7.7.9 Mammals

Terrestrial Mammals

Onshore and offshore oil and gas exploration and development in the Planning Area are the primary contributing activities in terms of cumulative effects on mammals on the North Slope. The primary effects from oil and gas exploration include habitat loss and disturbances that displace mammals from preferred habitat areas or impact their behavior. An oil spill could cause the direct harm or mortality to mammals due to its toxic effects, and also affect habitat.

Other factors that contribute to the cumulative effects on mammals on the North Slope include permitted activities such as non-oil and gas-related overland moves and development, scientific data gathering, recreation, hunting, and development. Global climate change is of concern because it may cause shifts in available habitat types, and a concurrent shift in mammal species that use these habitats. In addition, an analysis of cumulative effects to marine mammals cannot ignore effects to animals on migration and wintering areas, where impacts to marine mammals could be independent of activities on the North Slope. Because mammal populations can show substantial changes between years and even over longer periods of time, it is often difficult to determine if effects are accumulating at the population level, or merely reflect short-term shifts in population numbers.

Past Effects and Their Accumulation.

Activities Not Associated With Oil and Gas Exploration and Development. Excluding development associated with villages, military sites, rural airstrips, and hunting, non-oil and gas activities have had only a minor impact on terrestrial mammals. The amount of non-oil and gas activity on the North Slope is very low, and impacts consist primarily of short-term disturbance to individual animals. Aircraft disturbance of terrestrial mammals associated with resource-inventory survey activities (particularly by helicopter traffic) would be expected to have short-term effects on some caribou and muskox (particularly cow/calf groups), with animals being briefly displaced within about 1 mile of feeding and resting areas when aircraft pass nearby. It is unlikely that these effects persist today.

Approximately 7,000 to 11,000 mammals are killed annually on the North Slope by subsistence hunters. Based on surveys conducted in the 1980s and early 1990s (see Appendix J; Subsistence), Barrow residents killed approximately 1,800 mammals annually. An additional 200, 1,250, and 770 mammals were killed annually by residents of Atqasuk, Nuiqsut, and Anaktuvuk Pass, respectively. An additional 3,000 to 7,000 Porcupine Caribou Herd caribou are killed annually (ACIA 2004). Since mammal populations on the North Slope appear healthy and are stable or increasing in numbers (except for the Porcupine Caribou Herd, which has declined about 3.5 percent annually since 1989), hunter kill is likely replacing some of the loss of animals that would occur due to natural mortality, and effects are not accumulating.

Non-oil and gas development at former military sites and in villages has caused the loss of habitat and increased levels of disturbance. Approximately 2,500 acres have been disturbed for non-oil and gas development on the North Slope. These villages and developments are within or near important mammal use areas, including important summer, winter, and migration range for the TLH, WAH, and CAH caribou (see Maps 3-21, 3-22, 3-23, 3-24, 3-25, and 3-26). Development has led to the loss of habitat and increased disturbance effects to mammals. These effects, coupled with subsistence and non-subsistence recreational hunting pressure, have resulted in effects to caribou that persist today.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Loss of habitat and disturbance are the two primary factors associated with seismic activities and exploration that could affect mammals on the North Slope. Until recently, seismic testing resulted in few conflicts with caribou in Arctic Alaska (NRC 2003). Seismic surveys on the summer ranges of the CAH, TLH, and WAH caribou were conducted during winter, when the animals were not present. In a few cases, winter seismic survey areas at times overlapped with CAH, TLH, WAH, and Porcupine Herd caribou winter ranges, but impacts were probably limited to small groups of animals. It is likely that these activities briefly disturbed and displaced TLH caribou near seismic grids, exploration drill sites, and along ice roads and aircraft transportation routes. However, it is unlikely that this effect persisted after exploration was completed, and there was likely no consequential effect on the abundance or productivity of the caribou. More recently, seismic line intensity has increased as more 3-D surveys are conducted and exploration extends into the foothills of the Brooks Range and to the west of the Planning Area, areas where more wintering caribou are found.

Much of the ACP has been surveyed since the 1940s, and nearly all of the Planning Area (see Figure 4-1). Rolligons and track vehicles used during seismic exploration have left tracks on tundra habitats that are still visible today and that could make the habitat unsuitable for mammals (about 100 acres; Kevan et al 1995). Only a small portion of seismic and camp move trails are still in evidence. Use of lightweight vehicles, dispersing traffic patterns, minimizing sharp turns, and requiring surveys to be done when there is adequate snow and frost cover to protect the tundra have helped to minimize damage to vegetation used by caribou (Walker 1996).

Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on a report by the NRC (2003), in 2001, approximately 1,200 acres had been impacted by these sites in the past, and 740 acres of disturbed areas were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. As industry has shifted towards use of ice roads and pads during exploration, loss of mammal habitat has slowed greatly. Ice roads and pads have effects that could impact mammal habitat for several years, but would be unlikely to accumulate.

Oil and Gas Development and Production

Loss of mammal habitat from road and pad construction and gravel mining, and disturbance associated with development and production activities, are effects to mammals that have occurred in the past and that persist today. Peat and gravel roads, gravel pads, and gravel mines have caused the direct loss of mammal habitat, and also have led to the indirect loss of habitat from road dust and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel footprints had impacted over 9,200 acres, while gravel mines had impacted another 6,360 acres of vegetation. Of this, all but 70 acres of gravel footprint persisted in 2001, but over 4,500 acres of gravel mines were reclaimed.

Motorized traffic along about 400 miles of roads has disturbed, impeded the movement of, or displaced, caribou and other terrestrial mammals (NRC 2003). Disturbance of caribou from road traffic associated with pipelines has been shown to cause short-term displacement of caribou within about 1 mile of the road (2 ½ miles for parturient females and calves). Road traffic has delayed the successful crossing of pipelines and roads by caribou, and could have adverse energetic effects on some animals. Grizzly bears, wolves, Arctic foxes, and other mammals generally seem to cross roads more easily than caribou.

Road construction has increased access to previously undeveloped areas and has increased hunting pressure on terrestrial mammals from public and subsistence hunters in more remote regions of Alaska. Hunting pressure and harvests have increased for many wildlife species near the TAPS since its construction but have not produced adverse population effects (TAPSO 2001).

Oil development in the Prudhoe Bay-Kuparuk River Unit area has caused displacement of CAH caribou from a portion of the calving range, with a shift in calving distribution away from the oil fields (Nellemann and Cameron 1996; Lawhead 1997; Cameron et al. 2002; NRC 2003). The reduction in calving habitat use near oil development facilities could eventually limit the growth of the Arctic caribou herds within their present ranges and prevent the herds from reaching the maximum population size that they could achieve without the presence of development. It is possible that such an effect would not be apparent, because natural changes in the distribution and productivity of the herds would be likely to influence the abundance and growth of caribou populations over and above the effect of reduced habitat use caused by cumulative oil development. For example, the CAH caribou population estimate decreased from 23,000 in 1992 to 18,100 animals in 1995, and then rose to 31,857 caribou in 2002. However, recent information on the body weights of CAH cow caribou that calve west of the Sagavanirktok River, compared with CAH cow caribou calving east of the river, and suggested that disturbance displacement of cow caribou may be affecting CAH caribou productivity (Cameron 1994; Nellemann and Cameron 1996; Cameron et al. 2002). On the other hand, differences in densities and movements between segments of the CAH caribou on the oil fields and east of the fields may have contributed to the decline (Cronin et al. 1997). The NRC (2003) suggested that the combined effects of industrial activity and infrastructure, and the stress imposed by insects, might have contributed to the reduction in size of the herd seen from 1992 through 1995. Cronin et al. (2000) argued that population-level impacts from oil field development have not occurred for this herd. However, comparing the higher growth rate of the TLH to the growth rate of the CAH, Griffith et al. (2002) suggested that the CAH might have been influenced by development infrastructure after 1987.

The alteration of over 8,000 acres of tundra habitat in the Prudhoe Bay area has not had any apparent effect on the distribution and abundance of other terrestrial mammals, with the possible exception of Arctic foxes, which apparently have increased in numbers near the oil fields. Muskox have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge. There have been no apparent effects on wolves or other terrestrial mammal populations associated with this development.

<u>Spills</u>
The NRC's Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope found that most spills to date have had only local effects, and that there is no evidence that effects of spills have accumulated (NRC 2003).

Summary of Past Effects and Their Accumulation. Approximately 2,500 acres of habitat have been directly impacted by non-oil and gas development that continue to persist. Oil and gas activities have caused an additional habitat loss of 13,000 acres, and indirectly impacted approximately 21,000 acres of habitat that persist today. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to habitat are additive to future impacts and would be likely to persist for several decades or more, in the absence of an active reclamation program. Oil and gas development has altered the distribution of female caribou during the summer season and interfered with caribou movements between inland feeding areas and coastal insect-relief areas. Female caribou may also experience lower parturition rates when in close proximity to oil field development. It has also been suggested that declines in CAH caribou productivity in the early 1990s may have been the result of additive effects of oil field development and high insect activity, although populations of TLH, CAH, and WAH caribou have steadily increased since the mid-1970s. Thus, disturbance of caribou due oil field development may adversely affect caribou, but these effects are not readily apparent based on population trends. Other mammal populations (e.g., fox and grizzly bear) have been little affected, or may even have benefited from development on the North Slope. Subsistence and recreational hunting pressure has likely increased from historic levels due to increases in human populations and better access to the North Slope. Still, based on subsistence harvest surveys, subsistence harvest of mammals was relatively stable during the 1980s and early 1990s. Based on population trends of game mammals on the North Slope, hunting does not appear to be adversely affecting mammal populations.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, would continue to cause the loss of minor amounts of mammal habitat and disturb mammals. In most cases, loss of habitat would be temporary, lasting only a few years. DEW-Line and other military sites, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future, and for villages, likely increase in size, causing the loss of additional habitat.

Although not part of the development scenario for the Planning Area, it is reasonably foreseeable that the State of Alaska would build a new highway connecting the village of Nuiqsut and the National Petroleum Reserve – Alaska to the Dalton Highway. Assuming a length of 18 miles (to connect the Spine Road with the proposed bridge on the Colville River) and assuming the same impacts for construction as for other gravel roads and pads, such a road would bury about 80 acres of habitat and potentially alter the vegetation on up to several hundred more acres as a consequence of dust or gravel spray and changes in the moisture regime caused by changes in natural drainage patterns. Another proposal is to build a road from TAPS to the Planning Area. This road could be 100 or more miles in length, and would directly impact 420 acres or morel. An additional 80 acres could be impacted due to development of gravel mines. Erosion associated with soil disturbance, and spills from equipment and construction activities, could impact mammal habitat and caribou and other large-mammal movements. The road may increase the number of visitors and hunters to the Planning Area, resulting in increased disturbance and hunting pressure to caribou. In addition, if the road is opened to the public, it would increase the number of visitors, and hunters, to the Planning Area. Increased disturbance and hunting pressure could have adverse, and accumulating, impacts to mammal populations.

Oil and Gas Exploration and Development Activities

<u>Seismic Activities and Exploration</u>
About 1,300 miles of seismic trails are added each year. Based on projections developed for the Planning Area, this activity could impact up to 100 acres of habitat annually that would still show moderate to high levels of disturbance a decade later. However, based on recent studies of the use of newer seismic technologies, it is likely that impacts to mammal habitat that persist for a decade or more would be substantially less than this estimate (Jorgenson et al. 2003).

Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. These have been replaced in recent years by ice roads, airstrips, and drilling pads to reduce the costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, only a small amount of habitat is likely to be affected by long-term by exploration sites and facilities.

Oil and Gas Development and Production. Development activities that could contribute to cumulative effects to mammal habitat on the North Slope include oil development, including the Planning Area and northwestern and southern portions of the National Petroleum Reserve – Alaska; federal and state offshore oil development (through the construction of supporting onshore infrastructure); state onshore oil development; oil transportation; and road construction. All of these activities involve construction of infrastructure that would destroy habitat within the immediate footprint of the project and indirectly affect habitat through dust, flooding, changes in natural drainage patterns, snow drifting, increased water and air pollution, and oil and chemical spills.

Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, it is estimated that an additional 3,500 acres would be covered by gravel, and 500 acres impacted by gravel mines, in the next 25 years, much of this in the Planning Area. Approximately 9,200 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. An additional 4,000 acres of mammal habitat could be impacted by oil and gas activities between 2030 and 2055; another 9,200 acres would be indirectly impacted by development.

These impacts are additive to the impacts to habitat that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct (21,000 acres) and indirect (36,000 acres) that could still persist in 2050, direct and indirect impacts to habitat would occur on 0.43 percent of the ACP and 0.10 percent of the North Slope. These estimates do not take into account the quality of habitat that would be impacted on the North Slope. It is likely that the focus of future oil and gas exploration and development would be within the Barrow Arch, which is located in the ACP. Areas to the north and east of Teshekpuk Lake provide important calving, post-calving, and insect-relief habitat for TLH caribou (see Maps 3-24, 3-25, and 3-26). Thus, impacts to caribou and other mammals from development in this area would likely be much greater than if development occurred in areas that were little used by caribou.

Disturbance

Cumulative oil and gas development on the North Slope could result in a long-term displacement and/or functional loss of habitat for CAH, TLH, and WAH caribou. Future State of Alaska lease sales on the North Slope between the National Petroleum Reserve – Alaska and the Arctic National Wildlife Refuge, and in the foothills of the Brooks Range, would increase the amount of activity associated with oil exploration and development within the CAH caribou range. Future offshore leases in the Beaufort Sea could expose TLH and CAH caribou to additional activities related to oil and gas development (through onshore facilities to support offshore leases). Future lease sales in the National Petroleum Reserve – Alaska could expose a large number of the TLH caribou to exploration and development activities on their summer and winter grounds, and during migration. Animals from the WAH caribou would also be exposed to development activities in their summer range.

Development of onshore oil and gas resources in the Northwest National Petroleum Reserve – Alaska could result in construction of an additional pipeline that would pass through the Planning Area. Construction of a pipeline from the Northwest National Petroleum Reserve – Alaska east to the Kuparuk River Unit, or a southern pipeline route connecting to TAPS Pump Station 2, would temporarily disrupt movements of CAH and TLH caribou. Movements of TLH and WAH caribou from wintering habitat to calving grounds could be temporarily disrupted. However, pipelines associated with sales under this amendment would not have associated roads, and should therefore have minimal effects on caribou movements once construction was completed. State of Alaska oil and gas leasing offshore and adjacent to the CAH and TLH caribou ranges, as well as federal OCS leases in Harrison Bay west to Barrow, might include offshore pipelines that would come onshore within the TLH caribou range and connect with the facilities at Kuparuk. Potential offshore oil development adjacent to the TLH and CAH caribou ranges could result in increased surface vehicle traffic, which would disturb caribou along transportation corridors that would connect offshore oil discoveries with the existing infrastructure. Development also might increase disturbance of caribou by ground vehicles and air traffic in insect-relief areas along the coast, and perhaps reduce the seasonal use of coastal areas by cows and calves.

The reduction in calving habitat use near oil development facilities could eventually limit the growth of the Arctic caribou herds within their present ranges and prevent the herds from reaching the maximum population size that they could achieve without the presence of development. It is possible that such an effect would not be apparent, because natural changes in the distribution and productivity of the herds would be likely to influence the abundance and growth of caribou populations over and above the effect of reduced habitat use caused by cumulative oil development. The final Preferred Alternative and alternatives B and C would permit activities within the TLH caribou calving grounds; therefore, calving TLH caribou could be exposed to oil and gas development facilities and activities at a time of year when they are most sensitive to disturbance, possibly resulting in reduced calving success.

Oil development within the Planning Area could expose summering WAH caribou to noise and disturbance impacts. If development occurred in the southern part of the Planning Area, some WAH animals could be exposed to development activities during the insect season, and normal movement patterns could be disrupted. This herd is not currently exposed to oil and gas development activities in any other part of their primary range; therefore, cumulative impacts to the WAH caribou would be minor, although development in the Northwest National Petroleum Reserve – Alaska could increase these impacts. These effects on TLH, CAH, and WAH caribou would accumulate with other past effects on these herds, although the likely magnitude of these effects is difficult to ascertain, especially given the increase in herd sizes that have occurred in recent years in spite of oil and gas development on the North Slope.

The alteration of over 8,000 acres of tundra habitat in the Prudhoe Bay area has not had any apparent effect on the distribution and abundance of other terrestrial mammals, with the possible exception of Arctic foxes, which apparently have increased in numbers near the oil fields. Muskox have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge. There have been no apparent effects on wolves or other terrestrial mammal populations associated with this development.

The increase in the number of development facilities on the North Slope would be expected to increase the number of negative interactions between humans and grizzly bears, and to result in the loss of bears because of their attraction to human refuse. These interactions could eventually result in a decline in grizzly bear abundance near development areas. It is also expected that cumulative oil development on the North Slope would result in an increase in the abundance of Arctic foxes near development areas, which could affect tundra-nesting birds and could also pose a health hazard to humans through the spread of rabies among the growing fox population. Efforts to minimize the amount of refuse available to mammals should lead to a long-term decline in fox and other mammal populations near oil fields.

<u>Spills</u>

The oil industry is required to have oil spill response and clean-up capabilities, and small spills on lands or waters in the Planning Area or in existing or future North Slope oil fields are expected to be contained and cleaned up before substantial mammal and habitat loss can occur. In addition to mortality through direct contact with oil, some mortality could result through ingestion of contaminants in food and water, from the cumulative effects of the numerous small spills expected from the operation of any oil field.

The spills associated with reasonably foreseeable future projects could affect terrestrial mammals on the North Slope. Cumulative effects would depend on the number, size, location, and timing of spills, the type and effectiveness of the oil spill response, and the species and population of terrestrial mammals exposed to the spill. Potential oil spills from both offshore and onshore oil activities associated with federal and state leases would be likely to have a small effect on terrestrial mammals because comparatively low numbers of animals would be expected to be disturbed or contaminated, or to ingest contaminated food sources and die as a result. Spills would have mostly sublethal effects on terrestrial mammals and would impact only a very minor percentage of the available habitat. The greatest potential for impact to terrestrial mammals would be through disturbance impacts during response, cleanup, and rehabilitation.

Oil produced as a result of development in the Planning Area would contribute to less than 13 percent of future spills from TAPS, but would increase the number of onshore oil spills and would likely impact tundra systems in some instances. The amount of oil produced on the North Slope under the reasonably foreseeable future scenario is likely to continue to trend downward. As oil production slows, coupled with improvement in spill prevention and control technologies and training, the potential for effects to mammals should decline over time.

<u>Abandonment</u>
Abandoned gravel pads and roads could provide some benefits as insect-relief sites for caribou, and provide special habitat for burrowing species, such as Arctic ground squirrels and other mammals. The ultimate fate of the gravel pads and roads would not be known until closer to end of the production pad life. Permitting agencies could require that gravel be removed, in part or total, and the tundra revegetated. If other uses are determined by the permitting agencies to be preferable, the agencies could allow the permittee to leave the gravel pads in place, either revegetated or not revegetated. Removed gravel either would be disposed of or reused for another development.

Abandonment of airstrips could occur in conjunction with abandonment of pads. The gravel airstrips would be managed in a similar manner, depending on the decisions made by land managers and permitting agencies at the time of abandonment. Gravel airstrips would either be removed and the tundra revegetated, revegetated but otherwise left in place, or left in place and maintained for public use.

Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to caribou and other mammals that would be similar to, and at the same levels as that caused by traffic during construction and operations. If pads, roads, and airstrips were revegetated without removing the gravel, the habitat would likely not return to its current utility. If gravel was removed, habitat similar to that currently existing in the area could be created and used by mammals, though the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. The effects of habitat loss would accumulate, as described above, to the extent that habitats were not, or could not be, restored to their original condition.

Global Climate Change

Predicting the effects of climate change on terrestrial mammals is difficult because of the complexity of tundra ecosystems. It is predicted that an increase in abundance of deciduous shrubs, especially birch (less favorable caribou forage), and a decline in the abundance of grasses-sedges such as tussock cottongrass (an especially important food of calving caribou), would occur if temperatures in the Arctic were to increase, thereby reducing the amount of available forage for caribou on the North Slope (Anderson and Weller 1996). Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals, thereby potentially affecting their populations. Warmer temperatures could also result in increased insect abundance and periods of activity (NRC 2003). Changes in weather patterns could alter caribou movements and distribution. Calving grounds could shift in response to changes in vegetation. Insect-relief habitat could become increasingly important, because of increased insect abundance and activity. Coastal erosion and the inundation of low-lying areas along the coast due to increases in sea level may alter the availability and extent of insect-relief areas and may cause shifts in the usage of particular areas. Over time, areas that are currently closed to leasing could become less important to caribou, while areas that are open to leasing could become more important.

The ACIA (2004) noted that the Porcupine Caribou Herd, which is the largest migratory herd of mammals shared between the U.S. and Canada, has declined about 3.5 percent annually since 1989, possibly due to climatic effects. However, during this same period, the WAH, CAH, and TLH caribou populations have trended upward. A warming trend would stimulate faster plant growth in the spring, which should result in higher calf growth rate and allow cows to replenish fat reserves sooner. However, warmer springs have caused the Porcupine River to thaw earlier in spring. Historically, the herd crossed the river while still frozen to access calving grounds in the Arctic National Wildlife Refuge. With the river thawing earlier, cows that calve early must try cross the flowing river with their calves, causing thousands of calves to wash down the river and die (ACIA 2004).

Contribution of Amendment Alternatives to Cumulative Effects

Long-term impacts to habitat from seismic surveys in the Planning Area would occur on approximately 150 (Alternative A) to 200 (alternatives B, C, and D) acres. Impacts from ice road construction would occur on another 210 acres annually, while impacts from ice pads would occur on 30 to 270 acres during the life of the project; these impacts to habitat would be short-term and would not accumulate.

Development in the Planning Area would directly and indirectly impact 790, 3,480, 4,210, and 2,810 acres of mammal habitat for Alternatives A through D, respectively, if oil prices average $25/bbl. These habitat losses would account for 3 to 14 percent of the habitat projected to be lost due to development on the North Slope during the next 50 years. Given that the area most likely to developed under the action alternatives is located north and northeast of Teshekpuk Lake, areas that provide critical habitat for TLH caribou and other mammals, impacts to caribou, other mammals, and their habitats could be much greater than predicted based on amount of area disturbed. As shown on Maps 3-24, 3-25, and 3-26, the area to the north, northeast, and east of Teshekpuk Lake and to the coastline provides important caribou calving and insect-relief habitat. Because of its importance, Lease Stipulations K-9 and K-10 were developed for the final Preferred Alternative to provide special NSO protection to caribou habitat. Lease Stipulation K-11 would limit development in the Goose Molting Area to the north of the lake. Still, caribou and other wildlife would be exposed to oil and gas disturbance in their summer, and potentially winter, range. Depending on the types and locations of facilities, impacts to caribou and other mammals could accumulate, especially where species are concentrated, and could affect the long-term health of the local population. The effects to caribou and other mammals from oil and gas development would be less under the No Action Alternative and Alternative B, because all (No Action Alternative) or most (Alternative B) of this area would be closed to leasing under these alternatives. The effects would be greatest under Alternative C, since the entire area would be open to leasing. The effects from the final Preferred Alternative would be less than Alternative C, but greater than Alternative B, since some development could occur within this area. Offshore development associated with leases in the Beaufort Sea could impact small areas along the coast for staging and storage of materials, but is unlikely to impact large areas of habitat.

Conclusion

Cumulative oil development in the Prudhoe Bay-Kuparuk area encompasses more than 500 square miles, and hundreds of miles of gravel roads cross a large portion of the CAH calving range. More than 17,000 acres of habitat have been destroyed or altered where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are located on the Arctic Slope (USDOI BLM 1998b), and an additional 1,500 to 2,000 acres are expected to be directly affected by reasonably foreseeable development in the Northeast National Petroleum Reserve – Alaska. An additional 6,000 or more acres on the North Slope could be affected by construction of infrastructure associated with reasonably foreseeable future development on the North Slope.

Cumulative effects on caribou distribution and abundance are likely to be long term, lasting as long as the life of the oil fields. Any reduction in calving and summer habitat use by cows and calves as a result of future onshore leasing would represent a functional loss of habitat that accumulates and could result in long-term effects on the caribou herds' productivity and abundance. These impacts would likely be greatest under Alternative C and lowest under the No Action Alternative. However, this potential effect might not be measurable, given the great natural variability in the caribou population productivity. The effects of oil and gas activities in the National Petroleum Reserve – Alaska would be greatest on those herds that use the Planning Area (large numbers of TLH and smaller numbers of WAH caribou). If global climate change over the next several decades were to result in widespread changes in vegetation and insect abundance, effects to terrestrial mammals could be exacerbated and extend beyond the life of the oil fields. If these cumulative effects were to result in reductions in caribou populations, there could also be a reduction in the abundance of predators such as wolves, bears, and wolverines.

Marine Mammals

This section discusses the cumulative effects on ringed, bearded, and spotted seals, walruses, polar bears, and beluga and gray whales from oil and gas leasing and development activities. Current and proposed development activities could also affect other marine mammals whose ranges are located within oil tanker routes in the Bering Sea and Gulf of Alaska; the potential effects of development on marine mammal populations located along these tanker routes are discussed elsewhere (USDOI BLM 1998b). In addition to oil and gas leasing and development, other potential sources of effects to marine mammals in the Beaufort and Chukchi seas include North Slope fisheries activities, subsistence hunting, global contaminants, and the potential effects of global climate change.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Commercial fisheries compete with seals and beluga whales for prey species, and seals and whales have suffered mortality from entanglement in fishing nets. In addition, marine mammals thought to be raiding fishing nets have been shot by fishermen. Marine mammals have also been displaced from preferred feeding habitats by noise and visual disturbances caused by fishing activities.

Commercial fisheries on the North Slope are generally small operations that have likely affected only a small number of marine mammals. The extent of the impacts would depend on the level that fishing industry activities increased and their effects on the availability of prey species for marine mammals.

Before the Marine Mammal Protection Act became law in 1972, active sport hunting for polar bears off western and northern Alaska reduced the population (Amstrup et al. 1986). Since then, marine mammals can be hunted only for subsistence and handicraft purposes by Alaska Natives, and, unless populations are declared depleted, there are no federally-imposed limits on this type of hunting. Since 1988, hunting of polar bears from the southern Beaufort Sea stock has been controlled by a conservation agreement between the Iñupiat of northern Alaska and the Inuvialuit of the western Canadian Arctic, who hunt a shared population (Nageak et al. 1991). The number of animals taken each year is well documented; from 1988 to 1995, the average annual take of 58.8 bears was well below the estimated “potential biological removal level” of 73 (USDOI USFWS 1998) and therefore was considered safe.

Little is known about the number of ringed seals harvested, but they are an important subsistence resource to indigenous people throughout the Arctic (Smith et al. 1991). Alaska Native dependence on, and interest in, hunting marine mammals is influenced by many factors, including cultural involvement, employment, community wealth, logistics, and ice and weather conditions. The number of animals killed by hunters can be expected to vary accordingly. However, current legal restrictions should prevent harm to populations of these animals if they are properly enforced.

Approximately 7,000 to 11,000 mammals are killed annually on the North Slope by subsistence hunters. Based on information provided in Appendix J, Subsistence, approximately 5 whales, 1,130 seals, 20 walruses, and 15 polar bears are taken annually by Barrow subsistence hunters. Residents of Atqasuk harvest only a few seals annually. Nuiqsut hunters occasionally harvest beluga whales, polar bears, and walruses; approximately 50 seals are taken annually. Marine mammals, including bowhead whales, comprise about 32 percent of the subsistence harvest for Nuiqsut. Subsistence harvest surveys for Anaktuvuk Pass have showed that no marine mammals were harvested by residents during survey years from 1990 to 1995. Since marine mammal populations on the North Slope appear healthy, and are stable or increasing in numbers, hunter kill is likely replacing some of the loss of animals that would occur due to natural mortality, and effects are not accumulating.

Marine mammals are also killed in other ways. At least one ringed seal pup has been killed by a bulldozer that was clearing seismic lines on shore-fast ice of the Beaufort Sea. A polar bear died on the North Slope apparently after eating a container of dye used to mark temporary airstrips. It is not uncommon for residents to shoot polar bears in defense of life and property. Regulatory agencies and the oil and gas industry have made serious efforts to minimize interactions with polar bears, both to increase human safety and to safeguard the bears (Truett 1993).

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Seismic activities that occurred on offshore sea ice during exploratory operations in the Beaufort and Chukchi seas may have affected ringed seals. Seismic activities are conducted in a relatively small area; therefore, exploratory activities likely affected a different group of seals each year. Consequently, only a relatively small portion of the population would have been affected during any one year. During seismic operations, some seals could have been displaced from lairs within 500 feet of the seismic lines. These seals likely used alternate breathing holes and returned to lairs after the seismic equipment had passed through the area. A few pups could have been killed during seismic activities, and a small number of maternity lairs could have been abandoned or destroyed, causing the loss of a few pups. Since seismic activities would target different areas each year, ringed seal losses in a particular area would likely recover within a year or two and effects would be unlikely to accumulate.

Oil and Gas Development and Production

Gravel placement for construction of drilling and production islands, offshore platforms, drilling ships, and installation of buried pipelines are sources of habitat alteration. Gravel placement for island construction has covered relatively small areas of benthic habitat, which would be permanently lost. Installation of subsea pipelines may cause short-term effects to benthic habitats that would likely persist for less than 1 year. In general, marine mammals have large territories and are not dependant on local food sources, therefore the effects of habitat loss to marine mammals due to offshore oil and gas leasing and production probably have not accumulated.

Gravel islands and platforms could have localized effects on ice movements and formation around these structures, but would not be expected to affect the distribution of marine mammals. Naturally occurring variations in ice formation and movement would have a much greater effect on marine mammal distribution than localized changes near gravel islands and platforms. Noise and construction or other activities near gravel islands and platforms are more likely to caused disturbances that would affect a small number of marine mammals near these sites.

Effects of Noise and Disturbance

Noise from fixed-wing and helicopter aircraft traffic displaces marine mammals from preferred habitats, but animals likely return to these habitats shortly after the passage of the aircraft. Some animals would be unaffected by aircraft traffic or become habituated to this activity. Disturbance from vessel traffic could elicit greater responses from marine mammals because the duration of the disturbance would be greater than that caused by aircraft.

Beluga and gray whales could be affected by noise associated with the construction of gravel islands and drilling activities on gravel islands. However, since the migration corridor for most beluga and gray whales is far offshore, few whales have likely been affected. Much of this noise occurs during the winter and would not affect whales in their wintering areas. Some whales migrating close to gravel islands may have been deflected by noise disturbances (Richardson et al. 1995; Richardson and Williams 2003; NRC 2003). Noise associated with vessel traffic could have a greater effect on migrating whales than noise from other industrial sources, and noise associated with seismic exploration could have a greater effect on migrating whales than that of other types of vessel traffic. Construction of subsea pipelines from gravel islands to the mainland would occur during the winter when beluga and gray whales are on wintering grounds. If additional staging areas along the Northeast National Petroleum Reserve – Alaska coast led to increased offshore activities, the potential for marine mammals to be impacted by noise or other activities would likely increase. Staging areas for the Northeast Petroleum Reserve – Alaska may also increase potential for new offshore developments that could increase the amount of noise and other activities that could impact marine mammals.

Studies of the potential effects of disturbance on shore-fast ice on pupping ringed seals have showed that there was probably some displacement of ringed seals from areas close to artificial islands in the central Beaufort Sea (Frost and Lowry 1988), and that there was a higher abandonment rate of seal breathing holes close to seismic survey lines (Kelly et al. 1988). Noise likely affected haul out behavior of pinnipeds but no quantitative data are available. From data collected in the central Beaufort Sea from 1985 to 1987, Frost et al.

(1988) concluded that there were no broad-scale effects of industrial activity on ringed seals that could be measured by aerial surveys, but they also noted that there was little offshore activity during those years. Subsequent industry-funded monitoring studies for the Northstar and Liberty projects suggested minor effects on ringed seals from ice road construction and seismic exploration (Harris et al. 2001; Richardson and Williams 2000).

For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup 1993; Richardson et al. 1995). However, pregnant females and those with newborn cubs in maternity dens both on land and on sea ice are sensitive to noise and vehicular traffic (Amstrup and Gardner 1994). Seismic exploration has disturbed a bear in a maternity den (USDOI USFWS 1986). Current regulations require industry to avoid polar bear dens as much as possible (USDOI USFWS 1995b).

Oil Spills
The NRC's Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (2003) found that most spills to date have had only local effects, and that there is no evidence that effects of spills have accumulated .

Effects of Hazardous Material
Solid and liquid hazardous materials associated with Department of Defense and oil industry activities have been discarded or dumped at various locations on the North Slope, including the National Petroleum Reserve – Alaska. Many of these sites have been cleaned up, but low levels of hydrocarbons and pesticides remain at some sites. These localized sites probably do not represent a substantial threat to marine mammal populations, but effects likely still persist.

Summary of Past Effects and Their Accumulation. Industrial activity in marine waters of the Beaufort Sea has been limited and sporadic and has likely not caused substantial cumulative effects on seals or polar bears. However, noise and other disturbances may have displaced whales from preferred habitats in the past, although these effects are difficult to quantify and to determine if they accumulate.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Commercial fisheries would continue to compete with seals and beluga whales for prey species, and seals and whales would continue to suffer mortality from entanglement in fishing nets. In addition, marine mammals thought to be raiding fishing nets may be shot by fishermen. Marine mammals may also be displaced from preferred feeding habitats by noise and visual disturbances caused by fishing activities.

Commercial fisheries on the North Slope are generally small operations that are likely to affect only a small number of marine mammals. The commercial fishing industry in the northern Bering Sea, which is growing in size, could impact North Slope seals, walruses, and beluga whales wintering in this area. The extent of the impacts would depend on the level that fishing industry activities increased and their effects on the availability of prey species for these marine mammals. Prey species of seals and beluga whales, such as fish, could be directly impacted by the fishing industry, while benthic invertebrates that serve as prey for walruses could be indirectly impacted during trawling operations. Increased commercial fishing activities could also increase the potential for direct morality of marine mammals due to shooting, or displacement from preferred feeding habitats as a result of disturbance.

The Marine Mammal Protection Act allows the secretary of commerce to permit industrial operations (including oil and gas exploration and development) to take small numbers of marine mammals, provided that doing so has a negligible effect on the species and will not reduce the availability of the species for subsistence use by Alaska Natives. Regulations governing the permits identify permissible methods, means to minimize harm, and requirements for monitoring and reporting. The permits have been used to minimize the effects of on-ice activities on pupping ringed seals, to require planning and personnel training that minimize conflicts with polar bears, and to provide buffer zones around known polar bear maternal den sites. Annual surveys are conducted of subsistence resources to monitor population trends. If species populations are monitored and carefully managed, effects to marine mammal populations should not accumulate.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Seismic activities are conducted in a relatively small area; therefore, exploratory activities likely affect only a small group of seals and other marine mammals each year. Since seismic activities would target different areas each year, seal and other marine mammal losses in a particular area would likely recover within a year or two and effects would be unlikely to accumulate.

Oil and Gas Development and Production

No formal projections have been made of how likely effects on ringed seals or polar bears from future oil and gas activities are to accumulate with effects of other human activities. Future activity would occur in the Beaufort Sea from Barrow to Flaxman Island, and possibly to the Canadian border. Activity would occur mostly near shore, adjacent to onshore oil reserves, and development would entail methods and structures similar to those currently in use (gravel islands or bottom-founded structures, horizontal drilling, buried pipelines, and an emphasis on working during winter).

Full-scale industrialization of near-shore areas would most likely result in at least partial displacement of ringed seals. The frequency with which polar bears come into contact with people and structures is undoubtedly a function of the amount of activity in their habitats. Even with the best possible mitigation measures in place, it is certain that some bears would be harassed or killed. More human activity along the coast and near the shore could reduce the suitability of some areas for use by denning female bears. This effect is likely to be greatest east of the Canning River, especially within the 1002 Area of the Arctic National Wildlife Refuge, where the highest concentration of on-land dens is found (Amstrup 1993, Amstrup and Gardner 1994). Efforts to identify areas where polar bears are most likely to den in the eastern part of the North Slope (Durner et al. 2001), should improve the ability of regulators and industry to reduce disturbance of denned bears.

Oil Spills

An offshore spill would have a greater potential to affect marine mammal species than an onshore spill, although an onshore spill that spread to coastal habitats could affect small numbers of seals and polar bears. An offshore spill could affect beluga whales, gray whales, seals, walruses, and polar bears, particularly at the edge of the shorefast ice, which is an important habitat for marine mammals. The potential impacts to marine mammals from an offshore oil spill would depend on the location and amount of oil spilled, and the time of year. An offshore spill during the open-water season could have the potential to spread to a large area by the action of wind and currents, and could impact more marine mammals than a localized spill from an onshore source near the coast. A winter spill could affect small numbers of adult ringed seals and their pups. The effects of a winter spill could extend into the summer season if oil spill clean-up operations of a winter spill were not adequate to remove the majority of the spilled oil. Oil spilled during periods of broken ice is difficult to clean up and could persist for longer periods in the environment. In general, the likelihood of an oil spill is low, and marine mammal populations affected by an oil spill would likely recover within one generation. However, increased development of offshore leases, coupled with exploration and development in the National Petroleum Reserve – Alaska and ongoing development at Alpine, Northstar, Prudhoe Bay and Point Thomson, increases the risks of oil spills that could impact marine mammals in the area.

The potential for increased dependence on terrestrial habitats by polar bears, combined with increased human development from multiple lease sales and subsequent exploration and development within the National Petroleum Reserve – Alaska and ongoing development at Alpine, Northstar, Prudhoe Bay, and Point Thompson, increases risks to polar bears from oil spills. Increased encounters with humans and spilled oil or other contaminants could increase cumulative effects to the polar bear population.

Global Climate Change

Studies in recent years have indicated a general global climate change trend that has caused a reduction in the extent and thickness of the total Arctic sea ice coverage and could potentially affect food chains and trophic levels. Continued reduction in sea ice coverage could affect the distribution and abundance of seals, walruses, and polar bears in the Arctic (ACIA 2004). The potential effects of these changes on marine mammal populations are unclear, but there is speculation that a reduction in the extent of Arctic sea ice coverage would cause drastic reductions in seal, walrus, and polar bear populations. Another hypothesis is that a reduction in sea ice coverage would create greater areas of ice edge, which is productive habitat for seals and polar bears.

In the last decade, the numbers of polar bears occurring along coastal areas of the Beaufort Sea have been increasing (Stirling and Andriashek 1992, Amstrup and Gardner 1994, Amstrup 2000). The reason for the increase in numbers of polar bears is unknown but could be related to ice conditions. The USFWS (Schliebe et a1. in prep) recently compared the distance of the ice edge from shore (during fall months) with the numbers of polar bears observed on land. A significant correlation was found: as distance to the ice edge increased, so did the numbers of bears observed on land. The potential for continued reduction in ice cover from global climate change could result in greater numbers of polar bears occurring along the coastline for protracted periods of time, thereby also increasing potential conflicts with humans.

Other studies suggest that global climate change could be adversely impacting polar bear and seals. Stirling et al. (1999) documented decreased body condition and reproductive performance in polar bears in the western Hudson Bay that correlated with a trend toward earlier breakup of sea ice in recent years. The earlier breakup gives bears a shorter feeding season. They are leaner when they come ashore, and they must fast longer. Many ringed seals give birth to and care for their pups on stable shore-fast ice, and changes in the extent and stability or the timing of breakup of the ice could reduce productivity (Smith and Harwood 2001). Because of the close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland 1995).

Contribution of Amendment Alternatives to Cumulative Effects

Impacts to marine mammals from development in the Planning Area would generally be similar under the four proposed alternatives. The increased development scenarios of alternatives B and C, and the final Preferred Alternative, would contribute additional barge and aircraft traffic impacts and would require a greater number of coastal staging areas than the development scenario under the No Action Alternative. If additional staging areas along the Northeast National Petroleum Reserve – Alaska coast led to increased offshore exploration and development activities, the potential for cumulative impacts to marine mammals by noise or other activities would increase. The potential for a spill would be expected to increase with increasing levels of exploration and development. Thus, risks to marine mammals from a spill would be greatest under Alternative C, and least under the No Action Alternative.

Conclusion

In addition to noise and disturbance from existing oil development, seals, walruses, polar bears, and beluga and gray whales could be affected by future offshore development in the Beaufort and Chukchi seas. In addition, marine mammals wintering in the northern Bering Sea could be affected by disturbance from commercial fishing activities. Subsistence hunting of marine mammals by Alaska Natives is not likely to affect marine mammals at the population level. Disturbance could result in temporary displacement from preferred feeding habitats, and some animals could be shot by fishermen. An oil spill could affect marine mammals in offshore or coastal areas, with the impacts to marine mammals depending on the location and amount of oil spilled and the time of year. The effects of future habitat alteration associated with gravel island construction, platforms or other structures related to oil development would likely be minor. The presence of small amounts of hazardous materials, including hydrocarbons and insecticides, would likely have minor effects on marine mammals. The effects of global climate change on marine mammals are unclear. While a reduction in the extent of Arctic ice coverage would likely have a dramatic negative impact on ice-dependent seal and polar bear populations, an increase in the amount of sea ice edge resulting from global climate change may be beneficial. North Slope fisheries are small and likely have only a minor impact on marine mammal populations.

4.7.7.10 Threatened and Endangered Species

Bowhead Whale

Past Effects and Their Accumulation

The activities most likely to affect bowhead whales are subsistence hunting, marine seismic exploration, exploratory drilling, ship and aircraft traffic, discharges into the water, dredging and island construction, and production drilling. To date, there have been documented effects of industrial noise. The bowhead whale population has been growing steadily for several decades, however, despite oil and gas activities occurring in the Beaufort Sea and throughout the bowhead whale's range.

Activities Not Associated With Oil and Gas Exploration and Development. Bowhead whales, caribou, and fish are the main subsistence resources for Barrow, Nuiqsut, and Atqasuk, although subsistence resource harvests differ between communities. Bowhead whale hunting, which requires a great deal of cooperation and year-round preparation, is the impetus and focus of the Iñupiat sociocultural system. The bowhead whale is the preferred meat and the subsistence resource of primary importance, because it provides a unique and powerful cultural basis for sharing and community cooperation (see Appendix J; Stoker 1983 *in* ACI and SRBA 1984). Barrow is the only community within the area that harvests whales in both the spring and the fall, while Nuiqsut only harvests during the fall; however, some Nuiqsut hunters travel to Barrow to participate with Barrow whaling crews during the spring (NSB 1998).

Before commercial whaling, there were over 50,000 bowhead whales (estimated) in the north polar region. Commercial whalers discovered the bowhead whale as early as 1611 in the eastern Arctic and in 1848 in the western Arctic. Unregulated commercial whaling continued into the early 1900s, reducing the bowhead whale populations to near the point of extinction. Bowhead whales have been completely protected from commercial whaling since 1946; Eskimos have hunted "the whale" for centuries. In accordance with International Whaling Commission rules, Eskimos are legally allowed to hunt an allocated number of bowhead whales each year for food and oil.

During 1987 to 1992, Barrow whalers harvested 7 to 22 bowhead whales each year; approximately 10 whales are harvested annually (Stoker 1983, SRBA and ISER 1993). Some Atqasuk residents are members of Barrow whaling crews and return with shares after a successful harvest. Nuiqsut whalers have had unsuccessful whaling years in the past (20 whales from 1972-1995), but their success has improved in recent years. Unsuccessful harvests were common in the 1980s, with no whales taken in 1983 to 1985, or 1988; however, in the 1990s, the only unsuccessful years were 1990 and 1994 (USDOI MMS 1996a, USACE 1998). Nuiqsut whalers harvest two to three whales annually. Anaktuvuk Pass is unlike the other NSB communities in that resource users have no direct access to the marine mammal resource that in many ways defines the Iñupiat of the coast.

Whaling continues to be the most valued activity in the subsistence economy of the communities, even in light of harvest constraints imposed by International Whaling Commission quotas. In part a result of whaling quotas, the number of bowhead whales of the Chukchi-Beaufort-Bering Sea is estimated to exceed 8,000, those of the eastern Canadian Arctic and of the Okhostsk Sea in far east Russia are in the hundreds. Although the number of bowhead whales has increased from depressed levels in the early 1900s, the cumulative effects of commercial whaling persist today, as bowhead whale numbers are only one-fifth of numbers estimated to have occurred before commercial whaling.

Oil and Gas Exploration and Development Activities

Seismic Studies, Exploration and Disturbance

Marine seismic exploration produces the loudest industrial noise in the bowhead whale habitat. Some seismic surveys are conducted in winter and spring on the sea ice, but most are done in the summer-autumn open-water period. Thus, bowhead whales and seismic boats are in the same areas during the westward fall migration. In the nearshore Alaskan Beaufort Sea, nearly all the fall-migrating bowhead whales avoided an area within 12 miles of an operating vessel, and deflection of the whales began at up to 21 miles from the vessel (Richardson 1997, 1998, 1999; NMFS 2002). Noise levels received by these whales at 12 miles were 117 to 135 dB (NMFS 2002).

Disturbance to fall migrating bowhead whales also has been shown in relation to offshore drilling in the Alaskan Beaufort Sea. At the 1992 Kuvlum site, the approaching fall-migrating whales began to deflect to the north at a distance of 19 miles east of the drilling platform and bowhead whale calling rates peaked at about the same distance (Brewer et al. 1993). At the 1993 Kuvlum #3 site, the whales were nearly excluded from an area within 12 miles of the drilling platform (Davies 1997; Hall et al. 1994).

During the 1986 open-water drilling operations at the Hammerhead site, no whales were detected closer than 6 miles from the drillship, few were seen closer than 9 miles, and one whale was observed for nearly 7 hours as it swam in an arc of about 15 miles around the drillship (LGL and Greeneridge 1987). The zone of avoidance therefore seemed to extend 9 to 15 miles from the drillship. Acoustic studies done at the same time provided received levels of drillship noise that can be related to the zone of avoidance. At 9 miles from the 1986 Corona, site received sound was generally 105 to 125 dB (LGL and Greeneridge 1987); at 6 miles from Hammerhead, received sound was generally 105 to 130 dB.

Summary of Past Effects and Their Accumulation. Hunting and disturbance are the two primary factors that have impacted bowhead whales in the past and have accumulated. Although bowhead whale populations have recovered from very depressed levels in the early 1900s, they are still about 80 percent below estimated levels at their peak. Noise and disturbance associated with offshore seismic and drilling activities, and boat and barge traffic have impacted whales, although their long-term effects, and likelihood of having cumulative impacts to whales, are unknown.

Future Effects and Their Accumulation

If oil and gas activities continue in the Alaskan waters of the Beaufort Sea, the major noise would be generated with marine seismic exploration. Other significant noise would continue to be produced by exploratory and production drilling, island construction, and vessel transit. The probable consequences are diversion of animals from their normal migratory path, possibly into areas of increased ice cover, and less use of the fall migration corridor as feeding habitat.

If two or more types of disturbance occur at the same time or in the same general area, the effects could be greater than those observed from single sources. The greatest diversion would occur if two or more seismic vessels operated simultaneously with one just offshore of the other. Such a disturbing influence set across the migratory path could displace the whales seaward into areas where ice conditions are more dangerous for hunters, prevent some whales from passing, reduce use of the area as feeding habitat, and affect the behavior of the animals.

Activities Not Associated With Oil and Gas Exploration and Development. Non-oil and gas activities could also contribute to cumulative effects on bowhead whales. A small number of bowhead whales could be injured or killed as a result of entanglement in fishing gear or collisions with ships. It is expected that subsistence whalers from Alaska and Russia would to continue to harvest bowhead whales under a quota authorized by the International Whaling Commission. The subsistence harvest is carefully managed to prevent population level effects, and to allow the Bering-Chukchi-Beaufort Sea bowhead whale population to continue to grow. Although a few individuals would likely be killed, non-oil and gas activities are not expected to have much impact on the bowhead whale population and bowhead whale populations have increased steadily under current management.

Oil and Gas Exploration and Development Activities

Noise and Disturbance

Under the cumulative case, bowhead whales could be exposed to increased disturbance as a result of existing leases, future sales in the OCS, and activities not related to oil and gas exploration and development. Projects and possible lease sales in the OCS that could affect bowhead whales have been summarized in earlier documents (USDOI BLM and MMS 1998:IV.G.10; 2003:V.11; USDOI BLM 2004c:4.A.3.5), and are not repeated here. Information about the potential effects of offshore lease sales on bowhead whales has been discussed in detail in several recent documents (USDOI MMS 1997a, USDOI BLM and MMS 2003, NRC 2003, USDOI BLM 2004c). Those documents, and references therein, are included here by reference.

Development of the National Petroleum Reserve – Alaska and elsewhere on the North Slope, and offshore lease sales in the OCS, would result in incremental increases in vessel traffic, particularly barge traffic to supply bases and camps on the North Slope. Such increases would result in a greater likelihood for disturbance to bowhead whales, should barge traffic coincide with the fall migration of bowhead whales from Canadian waters to the Bering Sea. Impacts caused by barge traffic should be limited to temporary displacement of the migratory whales, or local, short-term changes in whale behavior.

Disturbance to migrating bowhead whales has occurred from seismic activities and offshore drilling (summarized in NRC 2003). Richardson and Williams (2004) reported a statistically significant displacement of bowhead whales from Northstar Island in 2001 when noise associated with Northstar Island was the loudest. This effect was attributed to noise from maneuvering vessels rather than from the Northstar Island project itself. The authors noted that the "southern edge of the migration corridor was slightly farther offshore at the noisiest times as compared with typical times." Results in 2002 were considered equivocal and there was no evidence of an effect in 2003. However, should boat and barge traffic along the Beaufort Sea coast increase as a result of development in the National Petroleum Reserve – Alaska and offshore leases, deflection of the bowhead whale migration could occur. It is unlikely that such deflection would have high impacts on individual bowhead whales or the whale population, but the deflection of whales away from the coast could impact subsistence hunting of whales.

Aircraft (fixed-wing and helicopters) flying at altitudes greater than 1,000 feet AGL generally do not impact bowhead whales. Any impacts to bowhead whales from aircraft flying at altitudes less than 1,000 feet AGL (during takeoff and landing) would likely be localized and include minor short-term deflection or changes in behavior. Aircraft would not be expected to have much effect on individual bowhead whales or the population.

Spills

If an oil spill were to occur as a result of development and production associated with any past, present, or reasonably foreseeable future development project on the North Slope or in the Beaufort Sea, some bowhead whales could be impacted. However, most whales directly exposed to spilled oil would likely experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, ingestion of oil-contaminated prey, baleen fouling, reduction in food resources, or temporary displacement from some feeding areas (NRC 2003). A few individuals could be killed if they were to experience prolonged exposure to freshly-spilled oil. Oil spill clean-up activities (e.g., vessel and aircraft traffic) could displace some bowhead whales, should those activities coincide with the fall migration and occur outside of Harrison Bay or other waterways within the barrier islands. Such displacement would minimize the potential for bowhead whales to be exposed to freshly-spilled oil, thereby reducing the potential for lethal effects. Impacts to bowhead whales from an oil spill are expected to be limited to short-term displacement or behavioral changes, and are not expected to have much cumulative impact on individual bowhead whale or the population. However, increasing exploration and development in the Beaufort Sea, coupled with production at Endicott and Northstar facilities, would increase the potential for a large oil spill to occur.

Abandonment

Noise from aircraft could, but in most instances would be unlikely to, disturb bowhead whales. The use of barges to remove materials from the Planning Area could also have localized impacts on bowhead whales if they were encountered during migration, but these effects would be short term and would not accumulate.

Global Climate Change

The tendency for bowhead whales to migrate closer to shore in light ice years versus heavy ice years in the mid-Beaufort Sea during autumn has been demonstrated (Moore et al. 2000; Treacy 2002b). McDonald and Richardson (2004) noted that the distribution of whales was close to shore in 2003. They estimated that roughly 75 percent of the population (~7,800 bowhead whales) came within about 17 miles of Northstar Island in the fall of 2003. Sea ice retreat over the last decade in the Beaufort Sea could lead to more exposure of bowhead whales to nearshore shipping noise.

Contribution of Amendment Alternatives to Cumulative Effects

Impacts to bowhead whales from development in the Planning Area would generally be similar to that discussed for marine mammals. The increased development scenarios of alternatives B and C, and the final Preferred Alternative, would contribute additional barge and aircraft traffic impacts and would require a greater number of coastal staging areas than the development scenario under the No Action Alternative. If additional staging areas along the Northeast National Petroleum Reserve – Alaska coast led to increased offshore exploration and development activities, the potential for cumulative impacts to bowhead whales by noise or other activities would increase. Should boat and barge traffic along the Beaufort Sea coast increase as a result of development in the National Petroleum Reserve – Alaska and offshore leases, deflection of the bowhead whale migration could occur. It is unlikely that such deflection would have high impacts on individual bowhead whales or the whale population, but the deflection of whales away from the coast could impact subsistence hunting of whales.

Conclusion

A few whales could experience sublethal or lethal effects from entanglement in fishing gear, collisions with ships, or encounters with subsistence whalers. Most activities related to oil and gas development onshore on the North Slope and in the Planning Area would not impact bowhead whales. There would be an increase in barge traffic that would contribute to cumulative impacts to bowhead whales from underwater noise and the presence of boat traffic. Bowhead whales could display a cumulative response to activities that produce underwater noise by increasing their distance from such sources by temporarily diverting their route of travel, or by temporarily changing their behavior. In general, these impacts would be minor and short term. Should development of the Planning Area stimulate greater interest in oil and gas activity offshore, these impacts could increase proportionately. Bowhead whales that come into contact with freshly-spilled oil could suffer temporary, non-lethal effects, and a few whales could suffer lethal effects. Bowhead whales could also be displaced by oil spill clean-up activities. Cumulative effects are likely to have only a minor impact on the bowhead whale population.

Spectacled and Steller's Eiders

Available information indicates that past, present, and future activities in the Planning Area, along migration routes, or on winter ranges could potentially contribute to cumulative effects on spectacled and Steller's eiders. These activities include subsistence and sport harvests (and associated lead contamination of eider habitat); commercial fishing; commercial development; wildlife research and surveys; proposed oil and gas exploration and development in nesting and wintering habitats; predation; environmental contamination; marine shipping; and recreation. Global climate regime shifts may also impact vegetation and other resources that could influence eider survival. Some of these activities may affect eiders at latitudes south of the Beaufort Sea and outside the summer breeding season, and may have affected eider populations as much or more than oil and gas activities on the North Slope and may have contributed to recent declines in these populations. Activities outside of the breeding grounds could result in oil or other toxic pollution effects, additional disturbance during the nonbreeding periods, or habitat loss or degradation that would add to cumulative impacts on listed eiders.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Activities not related directly to oil and gas development that occur on the North Slope, including wildlife research and survey activities, subsistence harvest, predation, village expansion, and potential environmental contamination, may have contributed to past cumulative effects to eiders. These impacts were usually localized and would have affected only small numbers of eiders and likely did not accumulate at the population level.

Noise and ground activities at summer camps could have disturbed feeding, nesting, or brood-rearing eiders in close proximity to the camps, potentially affecting the birds energy budget and productivity. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some eiders may have acclimated to predictable daily activities of camp personnel. Disturbance to birds from aircraft traffic and camp activities likely had the greatest affect within approximately 2,280 feet of the camps and little or no effect beyond 6,500 feet (Johnson et al. 2003b). Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. The greatest response to aircraft altitude occurred between 1,000 and 2,500 feet. Tundra-nesting eiders near summer camps may have also suffered mortality or egg loss due to predators attracted to anthropogenic sources of food at camps.

Subsistence harvest of spectacled eider adults and eggs has impacted these species, although overall numbers of birds and eggs taken over their entire range are not known. Spectacled and Steller's eiders provide an important food source for residents of Barrow, although common and king eiders are likely the species harvested most often by subsistence hunters due to their greater abundance. Atqasuk hunters also harvest eiders. Spectacled eider densities are medium high to high near Barrow and Atqasuk, thus opportunities to harvest this species near these areas may be greater than in other portions of the National Petroleum Reserve – Alaska (see Maps 3-33 and 3-34). Nuiqsut hunters harvest eiders and gathered and stored eggs from eider nests on the tundra. According to 2003 interviews, eggs are no longer gathered, and many residents avoid harvesting spectacled and Steller's eiders because they are a threatened species (see Appendix J).

Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta has likely been responsible for loss of spectacled eiders.

Non-oil and gas development at former military and other government sites and in villages has caused the loss of habitat and increased levels of disturbance. These sites also provide a potential starting point for hunting trips. Approximately 2,500 acres have been developed, with most of this development along the coastline, where eiders are found. Although there is limited information on historic numbers of eiders found in these non-oil and gas developed areas, development, loss of habitat, and disturbance, coupled with hunting pressure at "shooting station" near Barrow, and other recreational and subsistence hunting near other villages, has caused the loss of birds and habitat that has accumulated.

Oil and Gas Exploration and Development Activities

Seismic Activity and Exploration

Loss of habitat and disturbance are the two primary factors associated with seismic activities and exploration that could affect eiders on the North Slope. Most seismic surveys and exploration drilling activities would occur during the winter months when eiders are not present in the Planning Area. Therefore, these activities would have no direct impacts that would accumulate.

The use of airguns for boat-based seismic work in Teshekpuk Lake during the summer may have temporarily displaced eiders from feeding habitats while surveys were being conducted. Spectacled eider densities are medium high to high northeast of Teshekpuk Lake, and Steller's eiders have been seen nesting near Teshekpuk Lake (see Maps 3-33 and 3-34). Eiders near the shoreline could have been temporarily or permanently displaced from nests by boat disturbance, however, these surveys have only occurred a few times in the past, and it is unlikely that effects to eiders have accumulated.

Rolligons and track vehicles used during seismic exploration have left tracks on tundra habitats and many of these tracks are still observable years later (Kevan et al 1995). However, less than 100 acres of habitat has scars persisting today that could result in habitat loss for eiders. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still in evidence 8 years later, but that 5 percent of camp-move trails still showed moderate to high disturbance. Use of lightweight vehicles, dispersing traffic patterns, minimizing sharp turns, and requiring surveys to be done when snow and frost cover is adequate to protect the tundra have helped to minimize damage to vegetation used by eiders (Walker 1996).

Other sources of vegetative loss included gravel pads, airstrips, and roads near gravel structures at exploration sites. Peat roads constructed in the 1960s caused disturbances to tundra habitats that persist today. However, some evidence suggests that bird use of peat roads is similar to that of adjacent areas of undisturbed tundra (TERA 1991). Based on NRC (2003), in 2001, approximately 1,200 acres had been impacted by exploration sites in the past, and 740 acres of disturbance were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. As industry has shifted towards use of ice roads and ice pads during exploration, loss of habitat from seismic activities and exploration has slowed greatly. Still, ice roads and pads have effects that could impact eider habitat for several years, but would be unlikely to accumulate.

Water used in the construction of ice roads and pads has been withdrawn from deep lakes in areas adjacent to the road and pad locations. Winter water withdrawal has altered lake levels and adjacent habitats, although flooding and recharge during spring break-up have minimized the potential for long-term effects (Rovansek et al. 1996). Lake recharge during spring has probably limited effects on invertebrate populations used for food by birds in the spring, although these effects have not been studied directly. Bergman et al. (1977) and Derksen et al. (1981) reported that lakes with pendent grass had high levels of use by birds and seemed to be important to loons and waterfowl. Since use of lakes in the past has varied, and few lakes would have had water withdrawn over several years, it seems unlikely that the effects of past use of lakes for water withdrawals would accumulate.

<u>Infrastructure and Road and Pad Construction</u>

Effects to birds from loss of habitat from road and pad construction and gravel mining, and disturbance associated with development and production activities have occurred in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused the direct loss of eider habitat, and also have led to the indirect loss of habitat from the effects of road dust and alteration of natural drainage patterns. Although over 500 acres of peat roads still show evidence of disturbance, it is not clear that this disturbance has resulted in negative impacts to birds. Gravel footprints have impacted over 9,200 acres, and loss of vegetation and habitat associated with gravel footprints persists today. Gravel mines have impacted another 6,360 acres of vegetation, but over 4,500 acres of gravel mines had been reclaimed, much of it to deepwater lake habitat that would have some value for eiders.

The passage of vehicle traffic over gravel pads and roads results in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel can smother vegetation. The magnitude of these effects on habitat used by birds would depend on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed would generally be low on in-field roads, which would limit dust impacts to vegetation. Based on assumptions used in this amendment, approximately 30 acres of vegetation have been impacted by dust for each 100 acres of development, suggesting that 2,700 acres of vegetation may be indirectly affected by existing gravel roads and pads on the North Slope. These impacts are likely to persist as long as vehicle travel occurs on the pads and roads.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near these structures by producing areas of snow accumulation and by changing natural drainage patterns. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures.

These impacts are exacerbated by dust deposition and by the formation of impoundments. These factors have combined to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). However, impoundments have created new feeding and brood-rearing habitat that has been beneficial to some bird species. These effects, both beneficial and adverse, persist today on approximately 18,000 acres on the North Slope.

Disturbance

Numerous types of disturbances have resulted from oil and gas exploration, development, and production activities, including those caused by aircraft, vehicular, pedestrian, and vessel traffic, construction and drilling activities, noise and activity at facilities, and predator attraction. Impacts have been most prevalent where facilities were located in habitats with high bird concentrations, or if species with low population numbers or declining populations, such as threatened eiders, were disturbed.

Murphy and Anderson (1993) reported disturbances to birds as far as 500 to 685 feet from roads. Avoidance of roads, however, may have been related to an avoidance of heavily dusted areas on tundra adjacent to roads with high traffic levels rather than an avoidance of vehicular activity itself. Disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989, Derksen et al. 1992, McKechnie and Gladwin 1993; Ward et al 1999). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in Arctic oil fields at the Alpine field. Responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) and Ward et al. (1999) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet AGL often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. The potential effects of routine aircraft flights into airstrips would range from bird avoidance of certain areas to abandonment of nesting attempts or lowered survival of young. Johnson (1984) reported that at least three successful common eider nests were located within 975 feet of a helicopter pad on Thetis Island that averaged approximately 12 trips per day. Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic. Given the relatively low density of spectacled and Steller's eiders nesting in the National Petroleum Reserve – Alaska, disturbance resulting from aircraft activity would likely affect only a small percentage of the total populations of spectacled and Steller's eiders. The cumulative effects of disturbance on the North Slope have added only incrementally to impacts on eiders.

Predators

Predators such as glaucous gulls, Arctic foxes, ravens, and grizzly bears are attracted to anthropogenic food sources associated with oil field development, which may cause increased predation pressure on tundra-nesting eiders. There is evidence that nesting success for several species of ground-nesting birds may be lower in oil fields than in undeveloped areas (Troy 1996; Anderson et al. 2000; Sedinger and Stickney 2000). It is not known if these effects to eiders have been substantial enough to accumulate.

Collisions

Bird mortality has resulted from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development. Offshore activities are most likely to impact birds during the late summer/fall staging period, when relatively large numbers of loons, long-tailed ducks, eiders, and other waterfowl are staging and molting in marine areas. Eider collisions with vehicles, buildings or oil field infrastructure probably do not represent a significant source of bird mortality at the population level. However, eider losses due to collisions in developed areas accumulate with increases in development and add incrementally to other impacts.

Spills

No large oil spills have occurred on the North Slope. Small spills have occurred but cleanup and rehabilitation efforts have been successful and relatively few birds have been impacted (NRC 2003).

Marine Activities

Offshore oil exploration and development in state or federal marine waters of the North Slope rely on helicopter and barge traffic more than on fixed-wing flights. Much of this activity occurs during the winter when eiders are not present. However, helicopter activity, barge and crew vessel traffic, and spill response training activities also occur during the summer. During the summer open-water seasons of 2001 and 2002 at the Northstar development off Prudhoe Bay, helicopter activity ranged from 477 to 989 round trips, crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips (Williams 2002, Williams and Rodrigues 2003). Vessel traffic not related to oil development also occurs in marine waters off the coast of the North Slope. These disturbances may have displaced eiders from feeding and loafing areas and had a minor, short term impact on eiders.

Factors Outside of the North Slope. Numerous other factors could affect eiders at various locations around the world. Various types of contaminants and toxins from industrial and agricultural activities can enter either terrestrial or marine environments and affect eider mortality or reproductive success. Oil spills have been an obvious source of bird mortality at numerous locations around the world. Commercial fishing activities can cause changes in predator-prey relationships that could affect eiders that feed in offshore marine habitats. Eiders could also become entangled in fishing gear currently being used in commercial fishing activities or in abandoned gear that persists in marine environments. Many waterfowl species are hunted for sport during the fall migration and on the wintering grounds.

Subsistence harvest of spectacled eider adults and eggs has impacted these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta is likely responsible for loss of spectacled eiders. Although the proposed development scenario does not include a road connecting Nuiqsut with roads in the Planning Area, future construction of a road could allow access that would increase subsistence hunting pressure on spectacled and Steller's eiders, and increase the potential for lead shot contamination of eider feeding habitats. It is currently illegal to use lead shot while hunting waterfowl, although lead shot is allowed for hunting upland species. Illegal use of lead shot for hunting waterfowl, or legal use of lead shot for hunting upland species near waterfowl habitats, could contribute to the effects of lead poisoning on eider populations. Programs currently are underway by the USFWS and the NSB to inform hunters of harvest closures on these two species in an effort to decrease this source of mortality. Development along migration corridors and in wintering areas may result in habitat loss or disturbance that add to the cumulative impacts on bird populations. All of these factors can add to the cumulative loss of individual birds, and in some instances, can have population-level effects.

Summary of Past Impacts and Their Accumulation. Approximately 2,500 acres have been disturbed from non-oil and gas development on the North Slope. Although only a small portion of this area would have been used by eiders, much of it has occurred along the coastline and near Barrow, areas where spectacled and Steller's eiders are often seen (see Maps 3-33 and 3-34). Oil and gas activities have directly impacted approximately 13,000 acres of bird habitat, and indirectly impacted approximately 21,000 acres. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial developments, as well as oil and gas activities, these impacts to habitat are additive to future impacts and would be likely to persist for several decades or more, in the absence of an active reclamation program. Eider populations are greatest northeast of Teshekpuk Lake, and west of the Planning Area, thus the amount of eider habitat impacted by development is probably minor, but could increase in the future. Currently, the impacts of predators on bird populations may be reduced compared to the early years of oil field development, as industry has reduced the amount of garbage that is available in fields to attract predators. Other effects, including disturbance, are difficult to measure, but are likely accumulating as the number of developments and the amount of developed area increase. The gravel footprints of current developments are reduced compared to the footprints of previous oil field development, resulting in less habitat loss in modern oil fields. However, new development often relies on aircraft support for transportation of personnel and equipment that can increase disturbance to feeding, nesting, and molting eiders. Habitat loss and disturbance can add incrementally to the impacts of development on eiders.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development. Subsistence harvest of spectacled eider adults and eggs apparently continues to impact these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta is likely responsible for loss of spectacled eiders. Although the proposed development scenario does not include a road connecting Nuiqsut with roads in the Planning Area, future construction of a road could allow access that would increase subsistence hunting pressure on spectacled and Steller's eiders, and increase the potential for lead shot contamination of eider feeding habitats. It is currently illegal to use lead shot while hunting waterfowl, although lead shot is allowed for hunting upland species. Illegal use of lead shot for hunting waterfowl, or legal use of lead shot for hunting upland species near waterfowl habitats could contribute to the effects of lead poisoning on eider populations. Programs currently are underway by the USFWS and the NSB to inform hunters of harvest closures on these two species in an effort to decrease this source of mortality. DEW-Line sites, other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future. Villages are likely to increase in size, causing the potential loss of additional habitat.

Oil and Gas Exploration and Development Activities

<u>Aircraft and Vessel Disturbance</u>
Central Production Facility developments with satellite fields connected by gravel roads are proposed for the Planning Area and elsewhere on the North Slope. In addition, several staging areas and gravel extraction sites are also proposed. If CPF developments were connected to each other or to North Slope communities or existing oil fields by roads, they would likely require substantial fixed-wing aircraft and helicopter support, and occasional barge support during periods when eiders are present.

Oil exploration and development, which could occur in state or federal marine waters offshore of the Planning Area, would rely more on helicopter and barge traffic and less on fixed-wing flights. Much of this activity would occur during the winter when eiders are not present. Helicopter and barge and crew vessel traffic, and spill response training activities, could also occur during the summer. During the summer open-water seasons of 2001 and 2002, helicopter activity at the Northstar Development near Prudhoe Bay ranged from 477 to 989 round trips in each season. Crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips at (Williams 2002, Williams and Rodrigues 2003). Vessel traffic not related to oil development also occurs in marine waters off the coast of the Planning Area.

Fixed-wing and helicopter air traffic activity at the Deadhorse Airport, and at the Kuparuk and Alpine field airfields, is likely to represent the greatest source of air-traffic disturbance to eiders from currently developed areas. Any aircraft-related disturbance from new developments on the North Slope would represent additive effects. Continued activity to support future development on the North Slope likely would result in additional low-altitude flights over nesting, brood-rearing, staging, or migrating spectacled and Steller's eiders. Flight corridors would be established at remote airstrips in the Planning Area for transfer of equipment, supplies, and personnel, and for survey flights for wildlife or pipeline monitoring. The effects of disturbance from these activities could result in temporary or permanent displacement of foraging, nesting, brood-rearing, or molting/staging eiders, temporary or permanent nest abandonment, or alteration of eider energy budgets. Long-term displacement (1 year or more) from heavily used corridors could result in fewer young produced and somewhat lower survival of adults. However, some individuals might tolerate this level of disturbance and nest, rear broods, or forage within the air traffic corridor. Given the relatively low density of spectacled and Steller's eiders nesting in the National Petroleum Reserve – Alaska, disturbance resulting from aircraft activity would likely affect a small percentage of the total populations of spectacled and Steller's eiders.

Offshore air traffic could affect spectacled and Steller's eiders during the spring when birds are migrating to the breeding grounds, and during the summer and fall when birds are staging and/or molting prior to fall migration. Few spectacled or Steller's eiders would be likely to occur in the waters of the Chukchi and Beaufort seas during spring migration, and disturbance related to aircraft over-flights would likely be minimal at this time. Because open leads used by eiders as feeding habitat during spring migration are limited, however, disturbance during this period could affect eider energy budgets and be critical to the survival of the eiders migrating to these areas during spring. Spectacled eiders are likely to occur in higher numbers in offshore waters during summer staging; however, much more habitat is available at this time, and eiders disturbed by aircraft over-flights are likely to return to preferred feeding habitats or move to nearby areas to feed.

Vessel traffic associated with onshore development in the Planning Area, or with offshore development in state or federal waters, could disturb spectacled and Steller's eiders. The majority of barge traffic used to transport fuel, equipment, and supplies for onshore development would likely be staged from Prudhoe Bay, which has road access to ports at Anchorage. Barge traffic from Barrow would arrive from the west. Barge traffic would not occur until the open-water period begins in mid-July, and would not cause any disturbance to eiders migrating in the spring. Eiders staging in Harrison Bay or Smith Bay prior to fall migration could be temporarily displaced from feeding habitats by barge traffic, although most spectacled eiders would likely be further offshore than projected barge routes. Barge traffic from the Prudhoe Bay area to support offshore development could potentially impact eiders by causing temporary or permanent displacement from preferred feeding habitats. The extent of the impacts would depend on the location of the offshore development, the number of trips, and the vessel route. These additional effects would be additive with respect to cumulative effects to North Slope eider populations.

<u>Vehicle Disturbance</u>

Vehicular traffic and machinery noise and activity have the potential to affect spectacled and Steller's eiders in newly-developed areas on the North Slope. Similar types of disturbance occur in association with activities in existing North Slope oil fields. Construction of connecting oil development areas in the Planning Area with Nuiqsut or the existing Alpine field could increase traffic and disturbance levels in areas used by eiders, and may increase subsistence hunting activities in the Planning Area. These additional effects would be additive with respect to North Slope eider populations.

<u>Other Disturbance Factors</u>

In addition to the disturbance sources discussed above, disturbance may be caused by human presence associated with offshore exploration, construction and drilling activities, oil spill cleanup, subsistence hunting in newly accessible areas, and the attraction of predators to areas of human habitation. These factors would vary considerably in the amount of disturbance caused. Future offshore seismic exploration could affect spectacled eiders in marine waters of the Beaufort and Chukchi seas. Lacroix et al. (2003) studied long-tailed ducks and their reactions to seismic activities in the central Beaufort Sea and reported no major effects of seismic activity on movements and diving behavior. However, logistical and ecological factors may have limited their ability to detect subtle effects of seismic disturbance. Offshore seismic activities could potentially displace threatened eiders from preferred feeding habitats, and the changes to energy budgets could affect the survival of some birds.

Future development in the Planning Area or offshore areas would lead to an increase in the amount of human activity by the presence of oil field workers on roads, pads, or offshore structures; from increased activity by subsistence hunters or other recreational activities; or from activities of researchers conducting ground-based surveys for wildlife. Predators, such as foxes attracted to development areas, could cause losses of eider eggs or young. Much disturbance associated with commercial activities (excluding oil spill response) could be controlled by mitigation (or lease stipulations and ROPs, as proposed in this amendment). Although it is likely that behavioral effects to threatened eiders resulting from disturbance associated with oil and gas development would be additive to naturally occurring disturbances, there is no evidence for synergism, in which the combination of effects from natural and/or development-related factors would be greater than their additive effects.

<u>Habitat Alteration</u>

Temporary habitat loss or alteration could result from delayed snowmelt caused by accumulation of snow on tundra adjacent to roads and pads, dust deposition on tundra adjacent to roads and pads, thermokarst, seismic or other winter activities that affect tundra vegetation, and water withdrawal from lakes for winter construction activities. Permanent habitat loss would result from gravel mining and gravel placement to construct roads and pads. The formation of impoundments adjacent to roads and pads could result in temporary or permanent habitat loss or alteration. There is some evidence that impoundments may provide some additional habitat for spectacled eiders (Anderson et al. 1992; Warnock and Troy 1992; Noel et al. 1996), and that the formation of impoundments may not have negative impacts on threatened eiders. Similar types of habitat loss and alteration have occurred in the existing North Slope oil fields, and could occur in the Northwest National Petroleum Reserve – Alaska if future oil and gas development occurs there. In addition, future offshore development would have the potential to affect onshore spectacled and Steller's eider habitats, should gravel mining activities be required for construction of offshore drilling and production sites.

Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, it is estimated that an additional 3,500 acres would be covered by gravel, and 500 acres impacted by gravel mines, in the next 25 years, much of this in the Planning Area. Approximately 9,200 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. An additional 4,000 acres of potential eider habitat could be directly impacted by oil and gas activities between 2030 and 2055 and 9,200 acres could be indirectly impacted by development.

These impacts could be additive to the impacts to eider habitat that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct (21,000 acres) and indirect (36,000 acres) impacts that could still persist in 2050, direct and indirect impacts to potential eider habitat from activities on the North Slope would impact approximately 0.43 percent of the ACP and 0.10 percent of the North Slope. These estimates do not take into account the quality of habitat that would be impacted on the North Slope, or even if the affected habitat was suitable for eiders. However, it is likely that the focus of future oil and gas exploration and development would be within the Barrow Arch, which is located in the ACP. Highest population densities of spectacled eiders in the eider survey area on the North Slope are to the east of Teshekpuk Lake, near Cape Halkett (Map 3-33). Steller's eiders are also found to the north and northeast of Teshekpuk Lake (Map 3-34). Thus, impacts to eiders from development could be greater if development occurs in areas with high population densities of eiders.

Predation

There is evidence that predators of eiders, such as the Arctic fox, glaucous gull, and common raven, could be attracted to areas of oil field development by anthropogenic sources of food and denning or nesting sites. Increases in the numbers of predators in areas of development could have an additive impact on the effects of predation on threatened eiders. In recent years, North Slope oil field developers have installed predator-proof dumpsters to minimize attraction of predators to development. Lease stipulations were established, in part, to prevent human-caused increases in predator populations and require the adoption of methods to avoid attracting wildlife to sources of food, and to use the best technology available to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes.

Collisions

Eider mortality could result from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore or offshore oil and gas development. Offshore activities would be most likely to impact eiders during the late summer and fall staging periods, when relatively large numbers of eiders are found in marine areas. Migration pathways of eiders may include areas where offshore production facilities are constructed, so collisions between eiders and offshore structures, and watercraft and helicopters used for transport of personnel and equipment or responding to an oil spill, could occur. Research currently is being conducted to assess the potential for collisions between birds and offshore oil-producing facilities and to develop methods by which collisions can be reduced (Day et al. 2003a, b). The potential number and locations of offshore sites and their effects on spectacled and Steller's eiders would be additive to existing effects in North Slope oil fields. If these facilities were built in the future, consultation with the USFWS would occur to address potential impacts.

Spills

The oil industry is required to have oil spill response and cleanup capabilities, and it is expected that small spills in the Planning Area or in existing or future North Slope oil fields would be contained and cleaned up before substantial impacts to eiders would occur. A large onshore spill released in the Planning Area during the summer season could affect pre-nesting, nesting, and brood-rearing eiders. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for nesting, brood-rearing, or foraging by eiders, and oil entering freshwater aquatic habitats could spread more widely, potentially entering river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers, should eiders come in contact with oil, or by ingesting of contaminated prey. These effects would be additive to the effects of a spill in the existing North Slope oil fields, or to the effects of potential future spills in the Northwest National Petroleum Reserve – Alaska. Spectacled and Steller's eiders could also be affected by oil spills in other coastal lagoons and marine areas in molting or wintering areas.

If future oil field development were to occur in state or federal marine waters offshore of the Planning Area, there would be a low probability of a large oil spill. If one or more spills were to occur, substantial losses could result to eiders if oil were released during the summer/fall season when eider flocks were present. The number of eiders affected could potentially total tens to hundreds of individuals. Using average estimated spectacled eider density calculated from the USFWS survey data in the central Beaufort Sea area from Harrison Bay to Brownlow Point, and average severity of spill-trajectory paths (and thus, exposure of birds to oil), a USFWS model estimated an average of two eiders would be exposed to a large spill (5,912 barrels) within 30 days in July (Stehn and Platte 2000). However, in late July one group of 100 individuals was observed, suggesting a potential for much higher mortality should a spill occur in an area of relatively high spectacled eider density. An offshore oil spill with the greatest potential to impact spectacled eiders would be one that occurred in the deeper offshore waters of Harrison Bay, rather than in the offshore waters to the east or the shallower nearshore waters. An oil spill could also contaminate prey populations in eider foraging areas at any time of year, resulting in secondary impacts to eiders by affecting productivity and/or survival. Likewise, a spill on shoreline or coastal marsh habitat could affect eiders that were moving from onshore brood-rearing areas to the marine environment, or that inhabited the area in subsequent years. Molting and/or staging spectacled or Steller's eiders are known to use the lagoon systems in offshore areas of the Beaufort and Chukchi seas and Norton Sound. Hundreds to thousands of spectacled eiders could be impacted by an offshore spill that occurred in areas of high bird use, such as Kasegaluk Lagoon or Ledyard Bay in the Chukchi Sea and Norton Sound.

Global Climate Change

Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Naturally occurring plant succession on the North Slope is a relatively slow process (Billings and Peterson 1980), but how future global climate change may affect this process is unknown. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2004). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice. A few bird species, such as black guillemot, that feed near the ice edge may not be able to bring food to their young as the pack ice moves further offshore.

The increasing thickness of the active layer of soil above Arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Thawing of the permafrost may result in increased amounts of surface water in some areas. Areas of permafrost with substrates composed of fine-grained materials may be susceptible to drying, erosion, and desertification (ACIA 2004). Rising temperatures are likely to favor the expansion of the northern boreal forest into areas currently occupied by tundra. Studies suggest that climate change may increase woody vegetation on the North Slope (Chapin et al. 1995). Changes to the predominant vegetation type in areas dominated by sedges and grasses could influence use of those areas by threatened eiders. Global climate change may also result in an increase in shrubs at the expense of forbs and graminoid vegetation characteristic of arctic tundra. This could result in a loss of breeding-season habitat for threatened eiders. Rising seal levels resulting from increasing temperatures may further reduces the amount of tundra habitat available to nesting eiders by causing coastal erosion and by inundating low-lying areas. Such intrusion of salt water would be unfavorable to woody vegetation and would shift plant species toward those more tolerant of saline conditions (Funk et al. 2004). Salt marsh in general is considered high value habitat for waterfowl including the threatened eiders. These changes may be beneficial to some species, such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact threatened eiders and other tundra-nesting birds.

Contribution of Amendment Alternatives to Cumulative Effects

Potential impacts to eiders and eider habitat from seismic surveys in the Planning Area would occur on approximately 150 (Alternative A) to 200 (alternatives B, C, and D) acres. Impacts from ice road construction could occur on another 210 acres annually, while impacts from ice pads could occur on 30 to 270 acres during the life of the project; these impacts to habitat would be short-term and would not accumulate.

Development in the Planning Area would directly and indirectly impact 790, 3,480, 4,210, and 2,810 acres of potential eider habitat for alternatives A through D, respectively, if oil prices average $25/bbl. Wetlands, which are important to waterfowl and shorebirds, would comprise approximately 95 percent of this habitat loss. These habitat losses would account for 3 to 14 percent of the habitat projected to be lost due to development on the North Slope during the next 50 years. Given that the area most likely to developed under the action alternatives is located north and northeast of Teshekpuk Lake, areas that support some of the highest nesting densities of eiders on the North Slope, impacts to eiders could be much greater than predicted based on amount of area disturbed (Maps 3-33 and 3-34). Depending on the types and locations of facilities, impacts to spectacled and Steller's eiders could accumulate, especially where species are concentrated, and affect the long-term health of the population. The effects to eiders from oil and gas development would be less under the No Action Alternative and Alternative B, because all (No Action Alternative) or most (Alternative B) of this area would be closed to leasing under these alternatives. The effects would be greatest under Alternative C, since the entire area would be open to leasing. The effects from the final Preferred Alternative would be less than Alternative C, but greater than Alternative B, since some development could occur within this area.

Conclusion

The cumulative effects to spectacled and Steller's eiders caused by future developments both onshore and offshore of the Planning Area, and on lands to the Northwest National Petroleum Reserve – Alaska, would likely be greater than those caused by activities associated with the amendment alternatives alone. Given that oil and gas activities are more likely in the northern ACP, an area of the ACP where eider densities are greater, impacts to eiders would likely be greater than those based on the amount of area of ACP impacted. Disturbance of some individual eiders as a result of both onshore and offshore oil and gas operations is probably unavoidable over the long term. The cumulative effects from typical activities associated with exploration and development of oil and gas prospects in the Planning Area, lands to the west, and adjacent marine areas, could include small declines in local nesting or loss of small numbers of spectacled eiders, and potentially Steller's eiders, through effects on survival and productivity, predation pressure enhanced by human activities, and collisions with structures.

Declines in eider fitness, survival, or production of young could occur where eiders were exposed frequently to various disturbance factors, including aircraft and vehicular traffic and noise; pedestrian traffic; or noise from machinery, equipment, and facilities that could disturb nesting or brood-rearing eiders, or attract predators, and result in predation of eggs or young. In addition, potential increases in subsistence use and contamination of eider habitats could also add to existing development impacts. The effects of habitat loss and alteration would also be additive to those from existing development, although improvements in oil field construction and technology in recent years have provided methods to reduce development footprints. The effects of future project infrastructure on eider populations, although additive to natural effects, would be expected to be less severe than those caused by previous Arctic oil field developments.

Oil spills could cause direct or indirect eider mortality. Scenarios developed to address potential risks to eiders from oil spills generally report that low numbers of spectacled eiders would likely be affected; however, an offshore spill in an area of spectacled eider concentration could impact tens or hundreds of birds. Direct mortality to threatened eiders could also occur by collisions with vehicles or infrastructure. Overlap among the various sources of cumulative impacts could result in a reduced ability for threatened eider populations to recover from the potential negative effects of North Slope development, as well as from anthropogenic effects or natural occurrences anywhere in the species' range.

4.7.7.11 Cultural Resources

Cultural resources, including archaeological and historic sites and materials as well as traditional cultural properties, have a very limited ability to absorb cumulative impacts. Cultural resources are not a renewable resource. Cultural resources risk being destroyed by erosion, construction, excavation, data collection, and looting, through the removal of artifacts from their surrounding contexts, moving the material such that it loses context, or the removal or re-deposition of artifacts and their surrounding context to another location. Cultural properties, including camps, cabins, hunting and fishing sites, graves, and areas of particular religious or traditional importance, lose their integrity, and thus their potential eligibility for the NRHP, when they become degraded as a result of natural or human disturbance processes, or when the people who value these places can no longer access them, thus losing their cultural connection to the site over time.

The following section discusses the cumulative impacts on cultural resources as they occur from the past into the reasonably foreseeable future (1900-2100). Several key factors, as discussed in Section 3.4.1, could contribute to impacts on North Slope cultural resources during this time period, including oil and gas exploration (1920s through the present), military activity following World War II (e.g., DEW-line and White Alice Communication System [WACS]), federal laws and regulations concerning impacts to cultural resources (e.g., National Historic Preservation Act [1966], NEPA [1969], Archaeological Resources Protection Act [1979]), archaeological surveys (Section 106 and National Petroleum Reserve - Alaska 105(c) studies), and the collection of oral history and traditional land use sites by the NSB (e.g., Traditional Land Use Inventory).

Past Effects and Their Accumulation

Before oil and gas exploration and development, North Slope cultural resources were subject only to the effects of the natural environment, such as the forming, deforming, and destroying of existing sites, and the effects of human activity, such as Native people reusing found objects and materials, and explorers and other visitors taking material from the sites. Activities which have had the greatest affect on cultural resources in the National Petroleum Reserve – Alaska and along the Arctic Coast are most likely linked to both oil development and military activity, given that the area was designated as a Naval Petroleum Reserve in 1920.

Interest in the geology and archaeology of the North Slope began in earnest at the beginning of the 20th century, but access was generally limited to coastal or easily accessible areas (see Section 3.4.1.8 [European/Euro-American Expansion, Exploration, and Ethnographic Research). Effects to cultural resources in the National Petroleum Reserve – Alaska have been occurring since 1923 when oil and gas exploration and mapping began with USGS surveys of the Reserve, assisted by Native guides such as Simon Paneak. Early oil and gas ground-disturbing activities conducted by the U.S. Navy included exploratory drilling and geophysical and geological surveys, beginning in 1944, and shallow core tests and test wells drilled between 1945 and 1952. During this period, about 3,400 miles of seismic-reflection surveys and 391 miles of seismic-refraction surveys were completed within and adjacent to the Reserve (see Section 4.7.3.1; Past Exploration, Development, and Production on the North Slope and in the Planning Area). There has been little documentation of these early impacts, and there is no record of cultural resource identification or mitigation efforts from this early time period.

With the onset of the Cold War, military activity on the North Slope also affected cultural resources. During the 1950s, ground-disturbing activities associated with the rapid construction of the DEW-line and White Alice Communication System sites affected cultural resources; however, no effort was made during this period to mitigate effects to cultural resources potentially affected by industrial or military activities, despite protection provided to cultural resources under the Antiquities Act of 1906. Public testimony and historical literature have noted that cultural resources were disturbed or destroyed and access to traditional use sites was limited by industrial and military activity during this time period (Brown 1979). During the 1998 scoping meeting in Barrow for the Northeast National Petroleum Reserve – Alaska, Arnold Brower, Jr. noted that his grandfather's house and dwelling in Brownlow Point was demolished so that the DEW-line could have an airport in the same location.

Continued and increasing amounts of oil and gas exploration and drilling across the North Slope further affected cultural resources and Native peoples' relationships with their ancestral homelands. Following Alaska statehood in 1959, land selections were made by the state and federal governments, which did not include Native land ownership except as provided for under the Indian Allotment Act of 1906. No effort was made at that time to inventory, identify, record, or document Native land use or historic and archaeological sites as a result of these land selections. As a result of this lack of strong legal protections, oil development and production during this initial period severely impacted cultural resources and diminished some peoples' relationships with their individual and collective history. Sarah Kunaknana related the following experience while testifying at the scoping meeting held for Sale BF in Nuiqsut in 1979:

> *My name is Sarah Kunakanna and I have lived in this area since 1921. Our family stayed at Prudhoe Bay until late 1930's. Our old sod house is still standing today. When I visited last summer, I saw the pingos we used for duck blinds was a burning pit. Our place is a barge landing place instead of a fishing camp site. I guess people that are aware of Prudhoe Bay know that old shack on the east dock. That's where her house is still in position. That's the one she's talking about. There are a lot of old sites, camping sites, fishing sites along the line. They are there and are being threatened by development.*

The most intense oil and gas development activity occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). These developments occurred following the passage of the NHPA (1966) and NEPA (1969). These laws mandated the identification of cultural resources potentially affected by developments and mitigation of the impacts. In addition, these developments resulted in the discovery of many previously undocumented cultural resources. In part, increased oil and gas exploration and development activity prompted the NSB to initiate the Traditional Land Use Inventory (NSB Contract Staff 1979; Schneider and Libbey 1979). In 1977 and 1978, an archaeological survey was conducted in selected areas of the National Petroleum Reserve – Alaska, as mandated by Congress under Public Law 94-258, the Naval Petroleum Reserves Production Act. This survey resulted in the identification of 728 cultural resource sites. The Archaeological Resources Protection Act of 1979 added additional protections for cultural resources on public or Native-owned lands. In addition, the Native American Graves Protection and Repatriation Act of 1990 provided protection for Native human remains, sacred objects, and associated funerary objects on federal and Native-owned lands.

Summary of Past Effects and Their Accumulation

Effects to cultural resources from road and pad construction and gravel mining, and disturbance associated with development and production activities have occurred in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused surface disturbances that could have impacted cultural resources. Over 500 acres of peat roads were constructed, and gravel footprints have impacted over 9,200 acres. Gravel mines have impacted another 6,360 acres of vegetation, with over 5,000 acres of gravel being mined in rivers, where cultural resources are often found.

The above factors illustrate an improvement in the identification of cultural resources prior to ground-disturbing activities. Federal regulations and management stipulations regarding cultural resources were developed to mitigate impacts to cultural resources. However, increased development and exploration activities, while prompting the identification of the majority of cultural resources in National Petroleum Reserve – Alaska and the North Slope, have increased the cumulative effects to these resources.

Future Effects and Their Accumulation

Cultural resources are distributed unevenly across the North Slope. Areas with high probabilities of prehistoric and historic use are generally predictable, but specific subsurface cultural resources are often unknown until some sort of disturbance occurs, making it difficult to assess the cumulative impacts to cultural resources. The more oil and gas associated activities that occur, the larger the area affected and the greater the possibility that cultural resources would be impacted.

Increased oil and gas development activities on the North Slope would result in an increased need for gravel for infrastructure construction. The excavation of up to 1,000 acres of gravel during the next 50 years for well pads, roads, and airstrips could impact cultural resources. Most prehistoric and historic sites are located on well-drained ground, and on the North Slope, well-drained ground equates with gravel deposits, which are not common in the northern portion of the National Petroleum Reserve – Alaska. As a result, a gravel deposit with some degree of surface exposure would likely be associated with a cultural resource site. Therefore, the more gravel deposits excavated for the construction of permanent facilities associated with development, the higher chance that impacts to cultural resources would occur. Depending on the degree of development, gravel extraction could be as small as the amount needed to expand existing pads at Inigok, Puviaq, and Point Lonely, or as large as the amount needed to build roads connecting pads and airfields back to the infrastructure at the Alpine field.

Because of their surface or near-surface stratigraphic contexts, cultural resources are not well protected by soil and vegetation, and are vulnerable to any surface or subsurface-disturbing activity. Exploration would be more likely to affect cultural resources than development activities, because basic exploration activities, such as seismic work, ice road and pad construction, and overland travel affect a much greater surface area than the construction associated with development. Although snow cover and frozen ground may offer some protection to cultural deposits, they also cover the surface, making cultural resources difficult to recognize and avoid. In addition, most exploration-related operations occur in the low light conditions of winter; therefore, surveys of proposed activity areas and overland travel routes during the snow-free months preceding the initiation of winter exploration activities are important.

The effects of a large terrestrial oil spill on a cultural deposit would be directly related to the time of year and the context of the resource. If the spill occurred during late spring and early fall, then there would be a higher potential for an effect on cultural resources. Cultural resources could be contaminated by oil, making radiocarbon and other elemental assays valueless. However, the majority of effects would occur as the result of the cleanup rather than from the actual spill. During the winter months, both a spill and the resulting cleanup would have considerably less effects on surface and subsurface cultural resources, although warm oil could melt the snow and permafrost, damaging any underlying cultural resources. Hydrocarbon contamination could reduce the possibility that radiocarbon dating techniques could be reliably applied to affected material, making the dating of any recovered material problematic and increasing the cost of preserving and storing any such artifacts.

In general, impacts to cultural resources from future events would accumulate with effects that occurred in the past. Increased oil and gas exploration and development activities would increase the potential of impacting cultural resources. However, federal regulations and management policies are likely to remain in effect and would continue to allow for the identification of cultural resources and mitigation of impacts prior to ground-disturbing activities.

Global Climate Change

Climate change could cause changes to the environment and habitats of the North Slope that could seriously affect cultural resources and the people who value them (ACIA 2004). Climate changes could result in changes to vegetation coverage and type and the physical structure of the landscape itself (ACIA 2004). The thawing of permanently frozen ground could result in the erosion of river banks and beach bluffs, which would result in the destruction of known and undocumented historic sites as artifacts and sites were washed away. In addition, the thawing of permanently frozen ground could result in decreased preservation of subsurface cultural materials; natural processes, such as erosion, have exposed most known cultural deposits on the North Slope, particularly in areas with little or no organic soil and sparse vegetation. In most cases, this type of natural impact is viewed as positive rather than negative, as it reveals the presence of sites and usually generates few substantial effects. The action of flowing water, seasonal freezing and thawing (cryoturbation), thermokarsting, pingo and patterned earth formation, and solifluction can reveal cultural deposits, but can also cause minor impacts to cultural resources.

Aggrading and eroding shorelines along the Beaufort Sea coast and in the barrier islands have likely exposed or destroyed a large number of sites in areas too remote for archaeological recordation, such as Thetis Island. Increased maritime activity along the coastal areas, in waterways, and in lakes could result in increased erosion due to boat wakes, exposing and possibly destroying coastal and riverine cultural resources.

Contribution of Amendment Alternatives to Cumulative Effects

The greatest potential for cumulative effects would occur under Alternative C, as the entire Planning Area would be available for leasing, and the amount of development proposed under this alternative is greater than for the other alternatives. The potential for cumulative effects under Alternative B and the final Preferred Alternative would be similar. Although much of the northeastern portion of the Planning Area would be closed to leasing under Alternative B, the amount of development proposed under this alternative would be about 20 percent greater than for the final Preferred Alternative. Teshekpuk Lake would be deferred from leasing under the final Preferred Alternative, but the likelihood of a large number of cultural resources being found in the lake would be small. However, NSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to cultural resources. Under the No Action Alternative, 600,000 acres associated with Teshekpuk Lake Special Area would be closed to leasing. In addition, further lease sales and exploration and development in the South and Northwest portions of the National Petroleum Reserve – Alaska, and areas outside (e.g., Point Thomson), would increase the potential area of effects. While oil and gas exploration and development are the primary contributors of cumulative effects to cultural resources on the North Slope, other contributing factors include permitted activities, such as scientific data gathering, recreational use by the public, and activities ancillary to the BLM's management of the area. These non-oil and gas related activities are likely to result in indirect impacts. Activities outside the Planning Area would not be expected to have any impact on cultural resources within the Planning Area; however, the effects on cultural resources across the North Slope over time would be additive.

Lease stipulations and ROPs developed for the 1998 Northeast IAP/EIS ROD and this amendment would reduce the likelihood of oil and gas exploration and development activities impacting cultural resources. These include actions that require operators use low-ground-pressure vehicles and cease operations when the spring melt of snow begins; prohibit exploratory drilling near any known, long-term cabin or campsite; require setbacks along rivers, streams, lakes, cabins, and the coast, providing additional protection for cultural resources and traditional/cultural land use areas; minimize cultural and resource conflicts through an orientation program for personnel that would include instruction on the importance of not disturbing archaeological resources and sensitivity to community values, customs, and lifestyles; require an inventory of known traditional land use sites (NSB TLUI sites; see Appendix I) prior to any field activity so that these sites can be avoided and any damage from field activities can be mitigated; and require a cultural resources survey prior to any ground disturbing activity. If cultural resources are identified during surveys, BLM guidelines and policy require that all potential effects to the resources be mitigated to the satisfaction of the land manager.

Conclusion

Cultural resources are nonrenewable, and displacement or contamination of cultural resources could affect the cultural and scientific values of the resource. The cumulative effects of oil and gas exploration and development within the Planning Area and across the North Slope are difficult to estimate given the scattered nature of cultural resource deposits, their surface or near-surface contexts, and difficulty in predicting their location. As long as surveys and inventories were completed prior to exploration and development, the effects on cultural resources would be minimized. The accidental discovery or damage to sites, presently known or unknown, would to some extent damage those sites, but would also require measures to recover or record the remaining material, adding that information to the archaeological record of the North Slope.

The NHPA requires agencies, or their permittees, to complete a cultural resources survey before any undertaking occurs (i.e., a ground-disturbing activity, such as well drilling, construction of infrastructure or the construction of buried pipelines) on federal lands. The BLM's guidelines and policies require that all effects to any cultural resources identified during surveys must be mitigated to the satisfaction of the land manager and the SHPO. Lease stipulations and ROPs developed for the action alternatives would minimize or prohibit exploration and development activities near major rivers, reducing the likelihood of impacts to cultural resources.

4.7.7.12 Subsistence

The Iñupiat people of the North Slope of Alaska have created, over the span of their history, a set of tools, behaviors, and cultural values that enabled them not merely to survive, but to thrive and expand into much of the Arctic, from Greenland to Siberia. Only in the last 180 years has contact with Euroamericans gone from seasonal trading to long-term occupation, and only in the last 60 years have semi-nomadic Iñupiat settled into sedentary villages and been subjected to managed hunts and the cultural pressure of Euroamerican dominance of commerce, government, and media. The central conflict for the Iñupiat on the North Slope, since the beginning of prolonged contact with Euroamericans, has been the use and control of lands, competition for renewable resources, and the efforts by Euroamericans to impose changes in the culture, lifeways, and behavior of the Iñupiat through regulation. Since the mid-19th century, the Iñupiat have adapted to external pressures (e.g., commercial whaling, trapping, reindeer herding, military construction, oil and gas exploration and development) and regulatory actions (e.g., state and federal regulations and International Whaling Commission quotas; see Section 3.4.2.3 [Traditional Iñupiat Settlement Patterns and Subsistence Use Areas] and Appendix J.5 [Traditional Iñupiat Settlement Patterns and Subsistence Use Areas]). The following discussion addresses key events (past, present, and reasonably foreseeable future) and the impacts that these key events have had on subsistence activities over time and could have in the future. Despite the past pressures for change, what remains constant is the value of maintaining a relationship with the land and resources of their forefathers through hunting and gathering activities and associated kinship and sharing, reinforcing the importance of subsistence to the Iñupiat people of the North Slope.

Past Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, the Iñupiat were a highly mobile, geographically widespread, and technologically capable people who lived in dispersed, small communities based on family and social connections. They harvested local resources as needed and as available, with large numbers of people aggregating at certain points along the edges of the sea ice for the harvest of bowhead whales on their spring and fall migrations (see Section J.5). Once a sufficient number of whales were harvested, they held a giant festival and feast, dividing whale products among participants, and then dispersed throughout the landscape again. This pattern continued into the 19th century, with intermittent contact with Russian, American, British, and Norwegian traders, explorers, missionaries, and government representatives. This contact intensified when commercial whaling north of the Bering Strait began in the 1850s (see Appendix J.5).

With the advent of commercial whaling in the Pacific Ocean, European and American whaling ships worked further north, passing through the Aleutians in the mid-19th century, sparking a large number of independent people and companies harvesting marine mammal resources in the area. Commercial whaling north of Bering Strait lasted approximately 60 years, and introduced a number of impacts to the people and resources of the North Slope. Among these impacts were disease, the introduction of new foodstuffs, including flour, sugar, coffee, and tea, the increased availability of alcohol and tobacco, ongoing efforts at acculturation of the Iñupiat through missions and government schools, and efforts to centralize and make sedentary the highly mobile populations of Iñupiat. The failure of commercial whaling by 1910 coincided with a depletion in the number of whales available for harvest, making the ongoing subsistence harvest difficult for the Iñupiat remaining along the Arctic coast. Further complicating subsistence whale harvest was a decrease in the Iñupiat population due to disease, accidents, and poor health care. Iñupiat and whale populations gradually recovered during the 20th century. Following a reduced presence of Euroamericans in the beginning of the 20th century, due to the collapse of commercial whaling, the Iñupiat returned to their highly dispersed way of life, with additional emphasis on fur trapping and reindeer herding as a source of money to buy those Euroamerican goods they desired.

In the 1920s, the establishment of the Naval Petroleum Reserve and subsequent exploration activity marked the beginning of resource extraction activity in lands occupied by the Iñupiat of the North Slope. World War II increased the need for oil for naval vessels and industry, and began a period of intensified exploration and drilling activity on the North Slope. Lucy Ahvakana described her experiences during this period in scoping testimony for Lease Sale 170 in 1997:

> *When I was married to my first husband, we had a trading post in Foggy Island and Beach Pine, my first husband and I. We always go back and forth, trade, foxes, furnishing the food for Eskimos. Trappers live here. All of us -- a lot of us didn't get a chance to go to school. No school up here. You -- BIA didn't have enough money to put a school up here. They were trying to. And then we heard this oil company is coming. I moved to Barrow and these expeditions -- these looking for oil, Navys came. We went to Barrow. My husband said I had to go to Barrow to get my kids to school. So when we went there, we saw a bunch of barges. I thought it was Japanese invaded the Barrow. We were scared. And my stepdad went to shore. They seemed peaceful. We asked them, "What's going on?" The Navy's up here. They are looking for oil 1945. There were eleven barges. I know that Captain John Bablin, Sr., was the navigator for them. I moved to Barrow at that time.*

Ms. Ahvakana's testimony continued to describe an indigenous person's view of the changes brought by the introduction of oil and gas exploration and development to a remote and technologically isolated population. The Bureau of Indian Affairs was responsible for educating and promoting the welfare of the Iñupiat people, as well as building a hospital and a school in Barrow. By 1950, the Bureau of Indian Affairs was requiring families with school age children to relocate to population centers (e.g., Barrow) so that the children could attend school. Construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Children were sent outside to boarding schools, including Chemawa in Oregon and Mt. Edgecumbe in Sitka. The children that returned from these boarding schools often became spokespeople for the community and interposed themselves between the forces of development and the conservation of traditional ways of life. Some Iñupiat returned to traditional harvest areas seasonally, and in the early 1970s, following the passage of ANCSA, many traditional use areas were permanently resettled (e.g., Nuiqsut and Atqasuk). The events of this time period caused the formation of administrative offices (e.g., Alaska Federation of Natives, NSB).

During the mid-20th century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope as part of a pan-Arctic curtain of radar coverage and communications systems that spread from Greenland to the Aleutians. North Slope residents were no longer allowed to hunt near these locations, all of which were situated at or near important subsistence or residence sites. Barter Island, the site of a trading fair and several camps, drew Iñupiat people to settle there for jobs, though the site was built on the remains of several historic houses and graves. Operation of these sites by the military, and later contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, which led to avoidance of these areas by subsistence harvesters concerned about chemical contamination.

Postwar oil exploration and the sustained contact with Euroamericans, brought by activities associated with oil and the Cold War, resulted in additive impacts on subsistence resources, harvest patterns, and users. The establishment and enforcement of state and federal game regulations affected harvest activities and patterns (e.g., 1961 duck harvest protests in Barrow). These events encouraged the development of indigenous means of countering regulatory efforts dictated from outside the region and gave some voice to the Iñupiat people in defending their interests and promoting their causes (e.g., Alaska Federation of Natives in 1967 and Alaska Eskimo Whaling Commission in 1977). Out of these conflicts arose the first calls for scientific research into the peoples and lifeways of the Arctic, often based from facilities built by the military, such as the Naval Arctic Research Laboratory (NARL). Leasing of the offshore continental shelf areas for oil and gas exploration required further study, including study into the use of subsistence resources. These events also contributed to the organization of the communities in order to effectively address the issues brought up by development pressure, and to defend the rights of the Iñupiat people to maintain their way of life while incorporating the aspects of Euroamerican technology and culture that they found valuable. According to Worl, writing in one of the early research repots of contemporary subsistence uses by Iñupiat people, the "fate of subsistence lies not so much at the level of the hunter pursuing his game, but rather at the level of external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits" (NSB 1980).

The most intense oil and gas development activity, and increased impacts to subsistence activities, occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). In part, increased oil and gas exploration and development activity prompted the NSB to initiate the TLUI (NSB 1980), a repository for information on historic sites and present land use (e.g., hunting camps and cabins). Oil and gas development in the Prudhoe Bay and Kuparuk areas discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (see Appendix J, Section J.10.4 [Nuiqsut Contemporary Subsistence Use Areas] and Maps J-7, J-8, J-9, J-10, J-11, J-12, and J-13). Additionally, bowhead whaling quotas instituted by the International Whaling Commission resulted in the establishment of the Alaska Eskimo Whaling Commission.

Over the last 30 years, the Iñupiat have participated in public hearings for various industrial activities (e.g., lease sales, project scoping). During these hearings, the Iñupiat have consistently stated that they are concerned about the cumulative effects of industrial activities in their traditional subsistence use areas. They have noted the decline of fish populations caused by seismic activities, the diversion of caribou from traditional migration routes and calving areas caused by an increased number of low flying aircraft, the disruption of caribou movements by low pipelines, the ending of use of traditional harvest areas due to the avoidance of industrial areas by hunters, and the fear of the consequences of oil spills on subsistence resources. The specific experience of oil spills in the ocean were described by several elders due to the extent of the damage caused by an incident in the 1940s; described below is Thomas Brower's testimony for the 1975 Beaufort Sea hearings in Barrow:

> …I'm touching on this because of the fact that in 1944 or 45 when the Navy first came into this area, one of their tankers hit the bottom of the ocean, north of the point here, and they pumped 25,000 gallons of crude oil into the ocean; and as that thing scummed the ocean and started drifting toward these islands that you are talking about; it just hung in wide strips, some 40 to 50 feet wide along the edges of those islands. And all the ducks that came near it and the fur-bearing animals or the mammals (like the seal) went through it were soon blinded and thousands of them perished and I just don't know what happen to the fish that passed through those areas, but I'm pretty sure many of them died too.

This experience became the model for concerns about threats to subsistence species and continued use of these resources by Iñupiat people as oil development rapidly spread west from Prudhoe Bay. Some residents were profoundly concerned about impacts to marine resources, and so opposed any oil development in the marine environment. In the meantime, development on land proceeded to the area immediately east of Nuiqsut, raising concerns about continued subsistence access in the early 1980s. Bessie Ericklook noted in testimony at the 1979 Sale BF hearings her concerns about subsistence access to the east side of the Colville River and the effects of oil development on subsistence species:

> Trapping was abundant east of here. Now, we don't go over because of the oil field. Just recently, it is known that the foxes are very dirty, discolored and rabid in that area. Trapping is done elsewhere. We used to see grizzly bears around. Now, they are not around. Where's the caribou now? One summer when we used to walk miles looking for caribou, came across two dead caribou for unknown reasons. The animals have faced a change. We have faced a change since activity began. If there is to be further activity, the fish and the sea mammals will suffer and we will suffer too. We depend on the fish, wildlife and the birds, still, today. Oil development poses a threat to our lifestyle.

Impacts to subsistence cased by the seismic exploration programs on the North Slope have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blamed this activity for declines in fish numbers in the vast number of interconnected lakes and streams used by subsistence fishermen.

Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast IAP/EIS scoping meetings a consensus opinion among Iñupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in:

> Thank you Harry, I think I've heard that concern now from two other persons that directly told me that the existing seismic is already impacting subsistence hunters as we speak, that the seismic area has no game. The impacts, like Harry said, has scared and run the game off in one direction from that area already and numerous trips made by at least half a dozen hunters have attested that, that they've gone from the east side of the Ikpikpuk and Chipp River to the west side, where they're not there in that seismic area anymore. So these people have purchased gasoline and planned their trips just to find out that the seismic is in that area already and went up to those areas of normal hunting and the game is not there.

Subsistence is currently, and has been since the mid-19th century, part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (ADFG 2000). Important subsistence resources have varied in abundance and availability over time, due to environmental variation and human activities, especially commercial exploitation. Iñupiat adaptations to external pressures resulted in intensified use of specific resources (e.g., bowhead whales, caribou, and furbearers) and a decline in the use of other species and resources (e.g. brant, goose and eider eggs, and long-tailed ducks). For muskox, reintroduced on the North Slope in the last 20th century, and moose, which expanded their range into the North Slope in the past half-century, regulatory restrictions have limited Iñupiat harvests. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase introduced technological innovations to support subsistence activities (e.g., traps, boat motors, snowmachines). The constant advances in motorized transportation helped support the continued mixed economy and subsistence practices, partially mitigating the effects of concentrated populations and high levels of activity in particular areas by making travel faster and easier, although at greater cost in monetary resources. Avoidance of formerly utilized harvest areas due to industrial activity was made possible by motorized transportation, which allowed subsistence users to travel farther and faster than in the past. Increased institutionalization in response to increased industrial activity on the North Slope allowed increased Iñupiat autonomy and allowed the community to mitigate impacts with industry.

Cumulative effects from oil development are an important concern for North Slope residents. These concerns have been expressed in a number of different forums, including the 1998 Northeast IAP/EIS and Northwest IAP/EIS scoping meetings and hearings, scoping meetings for the *Alpine Satellite Development Plan EIS*, scoping meetings held for this amendment, and meetings held with North Slope residents in Anchorage, Nuiqsut, and Barrow during December 2003 and January 2004. Some of these concerns, as summarized in the *Alpine Satellite Development Plan EIS* (USDOI BLM 2004c), and brought up during public scoping meetings and other meetings with North Slope residents, are presented in Table 4-38.

Summary of Past Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, the Iñupiat were a highly mobile, geographically widespread, and technologically capable people who lived in dispersed, small communities based on family and social connections. They harvested local resources as needed and as available. Beginning with commercial whaling in the 1850s, and followed by establishment of the Naval Petroleum Reserve and subsequent exploration activity that marked the beginning of resource extraction activity in lands occupied by the Iñupiat of the North Slope, the Iñupiat have had adapt to the "external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits." Subsistence is currently, and has been since the mid-19th century, part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase introduced technological innovations to support subsistence activities (e.g., traps, boat motors, snowmachines). Avoidance of formerly utilized harvest areas due to industrial activity was made possible by motorized transportation. During this 150-year period, the Iñupiat have had to continually adapt to the constraints placed upon their subsistence activities and lifestyle by cultures other than their own. The effects of these constraints on the Iñupiat persist today and will accumulate with future effects on their subsistence resources and lifestyle.

Future Effects and Their Accumulation

Oil and gas development and leasing are likely to increase as compared to current conditions. Leasing and subsequent exploration and development are likely to occur not only in the Northeast, but also in the South, Northwest, and outside areas (e.g. Point Thompson and ANWR) of the National Petroleum Reserve – Alaska (see Table 4-32 for reasonably foreseeable oil and gas development). Planned development in the Planning Area would nearly encircle the community of Nuiqsut, making it necessary for subsistence hunters traveling in nearly every direction to pass through some kind of development en route to subsistence harvest areas. As noted in public testimony for this amendment, Iñupiat hunters are particularly reluctant to use firearms near oil production facilities, roads, and pipelines, so they would be unlikely to harvest subsistence resources in these areas even if leaseholders did not object to harvester access. Subsistence users currently avoid the Kuparuk and Meltwater areas because of the physical barriers that pipelines and elevated gravel roads pose to winter snowmachine travel, and subsistence users have expressed concerns about hunting close to oil production and processing facilities, because of perceived regulatory barriers (Ahtuangaruak 2001). Development near Fish and Judy creeks and Kogru and Kalikpik rivers could interfere with access to areas where half of Nuiqsut's subsistence fish and caribou harvests take place (USDOI BLM MMS 2003). Development along the north side of Teshekpuk Lake, outside the areas currently closed to leasing, could deflect or divert caribou hunted in that area by Barrow, Atqasuk, and Nuiqsut residents (SRBA 2003b).

Differing views are emerging on the North Slope regarding the effects of roads on subsistence. For example, some North Slope residents believe that roads could mitigate impacts on subsistence harvests from industry, could improve access to areas of the traditional subsistence range at times of the year when access would be difficult, would shift subsistence harvests to areas that are currently less utilized, and could change the mindset that has caused local subsistence users to avoid industry infrastructure. In addition, roads between Nuiqsut and infrastructure would allow Nuiqsut residents to live in town while employed by the oil industry, thus allowing the worker to spend time with family and continue to harvest subsistence resources. On the other hand, roads could have a detrimental effect on traditional patterns of subsistence harvests and resource availability. For example, a new road would increase access among Iñupiat and others to areas previously less utilized and would change the character of that area and could deflect subsistence resources and interfere with nesting waterfowl. Additionally, roads that increase access would result in increased competition between users (both local and non-local).

Oil production facilities operating in subsistence use areas could result in the contamination of subsistence foods, particularly fish, caribou, and marine mammals. Seismic exploration, exploratory drilling, and overland moves in the winter would continue to affect wolf and wolverine harvests. In the past, hunters observed these animals avoiding industrial activity areas, thus reducing their availability to Nuiqsut and Barrow hunters (Brower 1997). Harvest in these areas would require increased effort, risk, and cost on the part of subsistence users who pursue these animals for traditional clothing and crafts, as well as trade and sale of the hides. Oil production facilities operating in subsistence use areas could cause the contamination of, or perceived contamination of, subsistence foods, particularly fish, caribou, and marine mammals. The numbers of foxes, brown bears, seagulls, and jaegers could increase, as these scavengers are habituated to human activities and food, and their predation on nesting waterfowl could increase as well (Burgess 2000). This increased predation on nesting birds, eggs, and fledglings could result in local resource declines.

In the past, oil and gas activities have deterred subsistence users from using their traditional subsistence use areas. The continued expansion of this activity across the ACP from Prudhoe Bay westward could increase the area considered off-limits by resource users, deflect or divert important subsistence resources from their normal routes, and require users to travel farther to harvest subsistence foods (IAI 1990a). The continued increase in developed

Table 4-38. Summary of Traditional Knowledge/Local Knowledge.

Resource Category	Summary of Effects and Locations	Testifier
Physical Characteristics		
Aquatic Environment (water resources; surface water; estuarine waters and water quality; marine water quality; flooding regime; and ice conditions.)	*Comment*: As a result of past action the Itkillik River, which was once clear, is now a rusty color. *Effects*: Decreased water quality and a lack of fish in the Itkillik River, and less fish for subsistence use. *Area*: Itkillikpatt and the Itkillik River.	Bessie Ericklook, 1979 Beaufort Sea Lease Sale, public hearing in Nuiqsut.
	Comment: Fresh water river levels near Nuiqsut are decreasing and rivers are getting shallower and shallower each year. *Effects*: Lower fish population and less fish for subsistence use. *Area*: Nuiqsut and surrounding rivers.	Flora Ipalook, 1979 Beaufort Sea Lease Sale, public hearing in Nuiqsut.
	Comments: Loss of 2 to 3 feet of water in area lakes especially Shinmar Rock; level went down to 5 to 6 feet and therefore it cannot support any more fish. *Effects*: Less fish present due to decrease in water levels and increase in noise, and less fish for subsistence use. *Area*: Shinmar Rock.	Arnold Brower, Sr., 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: Lakes and rivers are shallower than in past. Streams and rivers that shoot off of Tsukpuk Lake use to be navigable by boat but they can't even go on them. *Effects*: Decreased access; reduced fish populations; less fish available for subsistence use; and less available area for hunting and fishing. *Area*: Tsukpuk (Teshekpuk Lake).	Daniel Leavitt, 1979 Beaufort Sea Lease Sale, public hearing in Barrow.
	Comment: All drilling operations consume a lot of water. The same thing will happen to the Sagavanirktok like it did to the Sagavanirktok River; it ran completely dry twice in 1 year. *Effects*: Less animals and fish in area. *Area*: Sagavanirktok River.	Raymond Neakok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: A combination of built up ice and snow drifts and water rising with the tide causes area flooding. *Effects*: Flooding to 12 miles up river causes danger for those with a dog team or on snowmachine, and less accessible area. *Area*: Howuerenokto and Ocean Point.	Nuiqsut Whaling Captains Meeting, 1996 Northstar EIS Project.
Atmospheric Environment (climate and meteorology; air quality; and existing ambient air quality)	*Comment*: High winds and larger than average swells. *Effects*: Increase in swells, which inhibited ability to travel to and from subsistence area. A decrease in subsistence due to decrease in safe travel. *Area*: Cross Island.	Archie Ahkiviana, 2001 Liberty Project, public hearing in Nuiqsut.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Atmospheric Environment (Cont.)	*Comments*: She (former health aid and physicians assistant) has noticed an overwhelming increase in asthma patients. The village makeup has not changed, still mostly Inupiaq. The most overwhelming issue was that the oil development around the gas community had increased and gotten closer. The worst nights were nights with many natural gas flares, as they release particles and some infiltrate the ground. We are seeing changes in the caribou and fish leaving them with lesions and tumors. Helicopter activity has diverted caribou away from us during hunting/subsistence gathering. *Effects*: Burning of natural gas and petroleum products has increased risk for respiratory problems in local residents. Increase in noise due to air traffic spooks caribou herd thus decreasing amount present in area. Infiltration of particles has caused disease in animals. *Area*: Nuiqsut and immediate surrounding areas.	Rosemary Ahtuangaruak, Mayor, 2003 Alpine Slope Development Plan, public hearing in Nuiqsut.
Biological Resources		
Fish	*Comments*: Use of explosives has killed or damaged many fish under the ice (traditional methods of harvesting involved using a hammer to strike the ice creating a noise killing the fish). *Effects*: Smaller fish population due to increase in noise and less fish for subsistence use. *Area*: Finmore Rock, Sitkulik and the Tripp River area.	Arnold Brower, Sr., 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: Use of explosives and compressors, especially in the winter months, has killed off or caused the relocation of those fish in local rivers and lakes. A method used by his father to gather fish involving pounding on ice to kill fish then drilling an opening downstream to gather the fish is no longer a feasible means of collection for him. Lakes where the fish are inland freeze over in the winter and they die due to lack of water. A compressor which sends off a very loud noise and vibrations can also kill a lot of fish. *Effects*: Decreasing fish population. They are no longer able to use methods passed down through generations for harvesting fish. *Area*: Rivers in the area between Barrow/Nuiqsut to Anaktuvuk Pass.	Joash Tukle, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Fish (Cont.)	*Comments*: We had some good fishing grounds up there and this fall we hardly even caught any. After the PET-4 seismograph party went through the depth of the lake is a little over 8 feet and a few blasts would clean the whole thing up. Traditional methods of hitting the ice then harvesting them out of the river downstream proved ineffective. *Effects*: Fish were not present following blasting and seismic activity and indirect effects as less fish available for subsistence use. *Area*: Area not specified.	Charlie Edwardson, 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: In an area where drilling had occurred, a net was placed in the lagoon near the ocean where my dad use to catch Arctic char. Even though we had the net there overnight we did not catch any fish. *Effects*: Fish population has declined in areas where drilling has occurred and less fish available for subsistence use. *Area*: Prudhoe Bay.	Jenny Ahkivgak (Okkingak), 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comments: Markers of the sounders that had been placed near the river. From that time on, the fishes in that river changed and are not there anymore right now. Sounders are killing them or driving them to the bottom of the stream. *Effects*: Fish were not present following sounding and less fish for subsistence use. *Area*: Area not specified.	Noah Itta, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comments: Since the use of dynamite in the river, there have been fewer and sometimes no fish found. They also disturbed the garden where they live off of. *Effects*: Fish not present after blasting events (up to 3 years after) and less fish available for subsistence use. *Area*: Area not specified.	Noah Itta, 2001 Liberty Development and Production Plan, public meeting in Nuiqsut.
	Comment: Fished in the Fish Creek area for Arctic cisco with mother (2 generations), since start of Alpine few years ago, hardly any fish to be caught in same area. *Effects*: Less fish in Fish Creek area. An indirect effect is less fish available for subsistence use. Area: Fish Creek, Nuiqsut, and surrounding areas.	Jimmy Nukapigak, 2003 Alpine Satellite Development Plan, public hearing in Barrow.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Fish (Cont.)	*Comments*: CD-6 is close to Fish Creek area where they fish in the summer. When they can't get fish in the Nigliq Channel they slide over to the other channel. It has lots of fish and they taste better than Colville fish. *Effect*: Putting in CD-6 could possibly disturb area and effect population of fish in the area historically and currently used for fishing. *Area*: Around proposed CD-6 and Nigliq Channel area.	Frank Long, Jr. 2003 Alpine Satellite Development Plan, public hearing in Nuiqsut.
Birds	*Comments*: In Inigok where a lot of drilling took place, bones were seen from birds that have been killed from the stuff they leave behind in the hole. Wildlife and waterfowl dying from contaminants being left after having conducted drilling activity. *Effect*: Contamination of waterfowl and wildlife resulting in death and steady decrease in migratory bird population. *Area*: Upulatook near Nuiqsut; Inigok.	Thomas Brower, Jr. and James Aiken, Sr., 1997 1998 Northeast IAP/EIS, scoping meeting in Atqasuk.
	Comment: There's a lot of activity out there, and occasionally we have mortality events in either fish, caribou or waterfowl, and these essentially go unaddressed. *Effect*: Increased mortality likely associated with increased development and human activity. *Area*: Area not specified.	Todd O'Hara, 2003 Amended IAP/EIS, scoping meeting in Barrow.
Mammals (terrestrial and marine mammals)	*Comments*: Seismic activity is displacing the animals. While hunting wolverines, which were being tracked, they had just been scared away from where activity (seismic) was occurring. There are no furbearers except for the foxes; did not see wolverines. *Effects*: Normal movement of animals is affected by activity making hunting and tracking more difficult and decreasing the number of available wolves and foxes for subsistence use. *Area*: Southside of Teshekpuk up in Pikes dunes and up the Ikpikpuk River.	Harry Brower, Jr., 1997 1998 Northeast IAP/EIS, scoping meeting in Barrow.
Social Systems		
Economy	*Comments*: Being a 3rd generation since pre-contact of Western civilization, they are faced with the fact they must either subsist off the land or take a 9:00-5:00 job. Cannot totally exist on subsistence anymore. *Effects*: Lifestyle drastically different than the way of their forefathers. Can no longer subsist off of the land and must work for the oil companies. Most are not qualified and jobs are short lived. *Area*: Barrow.	Sheldon Bogenrifle, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Economy (Cont.)	*Comments*: Qualifications have changed for those natives who desire to work for oil related companies. In the beginning, the only qualification was that you pass the UA, now to get a regular labor job or driving job you need a clean UA, a driver's license or a CDL, unrestricted, and NSTC card. *Effects*: Fewer are qualified or eligible for employment through the oil industry. Less available money for those living in the villages without qualifications (who are no longer able to completely subsist). *Area*: Village of Nuiqsut.	Bernice Kaigelak, 2003 Alpine Satellite Development Plan, public hearing in Nuiqsut.
	Comment: We face the highest unemployment rates today, even though we can see the Alpine oil field just 7 miles away from Nuiqsut. *Effect*: Limited economic benefits to local communities as a result of development nearby. *Area*: Area not specified.	Isaac Nukapigak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.
Subsistence Harvest and Uses	*Comments*: The continuous development from the east going west has heavily impacted some of their hunting grounds. She is also very concerned of future development because more infrastructures are being placed, which will divert our hunting grounds, make our hunting game that much further out to try to harvest. *Effect*: Reduction in subsistence harvest opportunities. Longer distance and increased effort required to obtain harvests. *Area*: Area not specified.	Annie Lampe, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.
	Comments: We're going further and further inland to hunt caribou, but when they do come around our area, it's a blessing and a curse because a lot of these animals are sick. And then when you don't catch what you need, you have to rely on the income that comes in. *Effects*: Increased effort required to obtain harvests. Decrease in the quality of local harvests. *Area*: Area not specified.	Big Bob, 2003 Amended IAP/EIS, scoping meeting in Barrow.
	Comments: The residents of our communities rely upon these resources for the sustenance of our families. The cost of obtaining western staples is often out of reach of many families. The health of our community is dependent upon our resources. Any activity that causes changes to our harvesting of the subsistence resources will impact upon our families. The sharing of our resources with our extended families ripples down with losses for them also. *Effects*: Reduced community health. Effects beyond the hunters themselves. *Area*: Area not specified.	Rosemary Ahntuangaruak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Land Uses and Coastal Management (land ownership; land use; coastal management; and the NSB Land Management Program)	*Comments*: After catching a musk-ok he was taken to court for being inside the industry boundary. Must now fight in court for harvesting in certain areas. *Effects*: Freely hunted subsistence areas are now trespassing on oil company land in order to reach the same areas restrictions on land use. Less muskox due to land use/ownership restrictions. *Area*: Area not specified.	Arnold Brower, Jr., 1998 1998 Northeast IAP/EIS, public meeting in Atqasuk.
	Comment: Open areas are now impassable due to dynamite left behind and wires scattered over the area. *Effects*: Change in use of land and less land to subsist from. Smaller amounts of available animals for subsistence harvest. *Area*: Area not specified.	Ruth Nukapigak, 1979 Beaufort Sea Lease Sale BF, public hearing in Nuiqsut.
	Comment: Her grandparents had a sod house and a cellar in Prudhoe Bay; now, they are unable to even access the site. They have no right to it even though their ancestors were there before the oil fields were there. Effects: Loss of access and previously owned land to oil industry. Area: Unspecified; Unspecified; Prudhoe Bay.	Sarah Kunaknana.
Transportation (road systems; aviation systems; marine transportation systems; pipeline systems; ice roads and platforms; winter Rolligon travel; and Alaska Railroad Corporation)	*Comment*: In order to cross the pipeline sometimes it is necessary to travel up to 10 miles off course. *Effects*: Longer travel time; indirect effect-increase in disturbed area due to having to travel off previously disturbed paths. *Area*: Nuiqsut area.	Thomas Napageak, Leonard Lampe, and Arnold Brower, 1997 1998 Northeast IAP/EIS scoping meeting in Nuiqsut.
Hazardous Materials/ Environmental Justice	*Comment*: As witnessed and experienced when working for the oil companies, toxic muds and caustic sodas are being dumped into the rivers and oceans. Most of the abandoned oil rigs I have worked on, the toxic muds are put in good little cubes, about 5,000 square yards of toxic muds go uncovered. The wastes are accumulating. *Effects:* Accumulation of toxic materials and waste. Indirect effects as animals are exposed to these hazardous materials. *Area*: Unspecified.	Raymond Naekok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Hazardous Materials/ Environmental Justice (Cont.)	*Comment*: When he was a boy, in his hometown during the springtime oil companies would clean out their silt and place the oils outside. Birds would stick to the oil and become unable to fly, eventually dying. *Effects*: Birds dying from inability to escape from oil exposed to the environment. Less birds for hunting and subsistence. *Area*: Area not specified.	Laurie Kingik, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: And these construction outfits, they bring in the old equipment, old run down—some of them older than I am, and when they break, the oil gushes out. It sprays all over. *Effects*: Release of oil to the environment. *Area*: Area not specified.	Big Bob, 2003 Amended IAP/EIS, scoping meeting in Barrow.
Caribou	*Comments*: Seismic testing involving dynamite is affecting caribou who consume the blasting powder; causes rabid behavior and effects on the animals. Caribou are affected by amount of waste materials. *Effects*: Poisonous powder used in blasting is being eaten by caribou thus decreasing well population and waste materials attaching to caribou (wires). Indirect effect is less healthy caribou for subsistence use. *Area*: Area not specified.	Raymond Neakok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: The pipeline from Oliktok to Kuparuk has caused the displacement of caribou from Cross Island to Teshekpuk. Few caribou have are crossing under pipelines and as a result there is displacement of caribou in the villages. *Effects*: Less caribou present following installation of pipeline. Less caribou available for subsistence use. *Area*: Oliktok to Kuparuk, from Cross Island to Teshekpuk.	Frederick Tuckle, Sr., 2001 Liberty Development and Production Plan, public hearing in Barrow.
	Comment: The 5 feet pipeline height had changed the caribou migration pattern due to past oil and gas developments. *Effects*: Disruption of caribou migration. Disruption of subsistence harvest and more effort required to harvest caribou. *Area*: Area not specified.	Isaac Nukapigak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.

Table 4-38. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Noise	*Comment*: Not far from the Nuiqsut site they are conducting wildlife surveys by air and by foot creating an enormous amount of noise that upsets, disrupts, and displaces perhaps some of their only opportunity to go get their game, especially caribou in the area are scared and may run off because of these impediments that arrive are not natural. Hunters must go further to gather game. *Effects*: Fewer caribou present following activity and surveys; thus, fewer caribou available for subsistence use. *Area*: Colville River Delta to the east side by Ulumniak.	Ruth Nukapigak, 1998 1998 Northeast IAP/EIS, public hearing in Nuiqsut.
Visual/Aesthetic	*Comment:* Flames out on the project oil platforms are very close to the whaling base of Nuiqsut called Cook Island so concerns on the migration and impacts to whales exist. Flames spook both the whales and crews who are harvesting whales for subsistence. *Effects*: Fewer whales in the area due to flashing gas flares. Increases danger for subsistence hunters. *Area*: Cross Island	Leonard Lampe, 1996 Northstar EIS Project, Nuiqsut public scoping meeting.

area would reduce the amount of suitable lands available for Nuiqsut residents to harvest necessary subsistence resources away from oil and gas facilities. If permanent facilities were constructed in the Planning Area, Nuiqsut hunters could be compelled to travel very long distances to harvest subsistence resources at a greater cost in terms of time, fuel, wear and tear on people and equipment, and lost wages.

The International Whaling Commission sets the quota for the number of bowhead whales that Alaska Eskimos may harvest. This quota is based on both the biological status of the bowhead whale stock, as well as the documented Alaska Eskimo cultural and subsistence need for bowhead whales. It is likely that the International Whaling Commission would perceive increased industrialization of the National Petroleum Reserve – Alaska and rest of the North Slope, including development of coastal staging areas, heightened interest in adjacent offshore areas, and increased oil spill risks, as placing increased pressure on the endangered bowhead whale population. As industrialization proceeds along the Alaska North Slope, it will increase noise, vessel traffic, and the potential for an oil spill in the Beaufort Sea. In response to concerns that noise, vessel traffic, and the potential for a catastrophic oil spill poses a threat to the feeding grounds of the western Pacific gray whales, the International Whaling Commission has already passed a resolution that the onset of oil and gas development programs is of particular concern with regard to the survival of this population. Because the North Slope is the fall migration path and feeding grounds of the bowhead whale, it is likely that the International Whaling Commission would seriously consider the effects of industrialization on the bowhead whale population. Although the International Whaling Commission is unable to directly control industrial activities, they are able to control the Alaska Eskimo subsistence harvest quota and could reduce this quota as a means of protecting the species confronted with the effects of increased industrialization. If the International Whaling Commission considers the threat of industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope as well as to the Iñupiat in other communities who receive whale meat from the harvest.

Global Climate Change

Changes to the environment and habitats of the North Slope resulting from climate change could seriously affect subsistence resources and resource users (ACIA 2004). Changes to species diversity, numbers and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape itself could result from changes in climate regimes. Erosion of river banks and beach bluffs, resulting from the thawing of permanently frozen ground, could have severe effects on how subsistence practices are undertaken, as subterranean ice cellars for storing food harvested at remote places for later transportation to the village could collapse and cabins and camps could continue to be washed away. Erosion and climate changes could change water levels in rivers and streams, making transportation by boat and land more difficult, damaging or destroying infrastructure, and reducing water quality (e.g., turbidity, dissolved oxygen) until some waters are no longer are suitable fish habitat. Water flows would increase as glacier fed streams absorbed melting runoff and decline as the glaciers retreated, also changing water quality, fish habitat, and possibly damaging the river valley microhabitats along the north-south oriented rivers of the North Slope. Climate changes could reduce suitable browse for caribou and muskox, possibly shifting their range away from the communities or reducing their numbers. The same habitat changes may favor moose, which Iñupiat hunters perceive as less suitable as subsistence staples because they are solitary, require large ranges per animal, and do not predictably move in large numbers to specific areas, making it more difficult and energy intensive to harvest them. Due to their size, moose also require more effort to butcher, transport, and process than caribou and muskox (ACIA 2004). Climate change could result in a reduction in marine ice and a less safe ice edge, affecting spring marine mammal hunting, including Barrow spring bowhead whale hunting.

Marine currents could be changed by the retreat or disappearance of the ice sheet, shifting some marine mammals much further offshore or to where the habitat is still available, perhaps as far as High Arctic Canada. Migratory waterfowl numbers could decrease, change their migration paths, or go extinct if key habitat was changed. Marine currents could change the distribution and habitats of anadromous and amphidromous fish, which are key subsistence resources for the communities. Warmer temperatures could also reduce habitat for freshwater fish, or change populations to those more suited to warmer waters. Rising sea levels could inundate low-lying coastal lands along the North Slope and change the salinity of surface and ground water, further changing fish and waterfowl habitats and subsistence resource uses. As the landscape becomes less hospitable for human occupation, people could move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. As a result, community stresses would increase and traditional knowledge of the landscape, environment, and resources would be devalued if conditions changed rapidly. Reduced levels of stratospheric ozone could increase levels of UV exposure to northern peoples, lowering immune system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA 2004).

Effects to subsistence in the foreseeable future are primarily a continuation of effects from the last century. Changes in oil and gas exploration and development technology, as discussed in Section 4.7.4 (Advances in Technology), could mitigate some of the effects observed in the past (e.g., population declines in fish as a result of seismic activity). Increased oil and gas activity and climate changes are likely to continue to affect subsistence activities. For example, additional losses of traditional subsistence harvest areas would occur and traditional subsistence resources may no longer be available for harvest (e.g., some species of migratory birds). Subsistence users would continue to travel farther to harvest resources, but are unlikely to cease subsistence harvests given the strong cultural continuity and value of subsistence activities.

Contribution of Amendment Alternatives to Cumulative Effects

Under the cumulative case, currently planned development in the Planning Area and winter exploration throughout the entire area would continue. Seismic exploration would occur in winter and would include the drilling of exploratory and delineation wells in areas not excluded by buffers. Exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, and furbearers, affecting subsistence users in Nuiqsut and to a lesser extent Atqasuk, Barrow, and Anaktuvuk Pass. If permanent development is pursued in areas newly opened to exploration and leasing under the action alternatives, Iñupiat users could no longer utilize an area from 5 miles to 25 miles around those facilities for subsistence uses. The areas that would be potentially off-limits due to oil and gas development could represent a majority of the portion of the subsistence range that is presently undeveloped, and includes areas of great traditional and historic significance and key habitat areas for several crucial subsistence species.

Allowing leasing and development of all or portions of the Teshekpuk Lake Special Area under the action alternatives would dramatically reduce the amount of undisturbed habitat to caribou, waterfowl, fish, and other subsistence species. These effects to subsistence species would be greatest under Alternative C. Effects to subsistence species would be similar under Alternative B and the final Preferred Alternative. Although much of the northeastern portion of the Planning Area would be closed to leasing under Alternative B, the amount of development proposed under this alternative would be about 20 percent greater than for the final Preferred Alternative. Teshekpuk Lake would be deferred from leasing under the final Preferred Alternative, protecting waterfowl and other subsistence species that use the lake. In addition, NSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to subsistence resources. Under the No Action Alternative, 600,000 acres associated with Teshekpuk Lake Special Area would be closed to leasing.

Avoidance of additional areas as a result of Lease Stipulation D-2, which allows for the development of permanent facilities for exploration (if that is more economical), would impact the subsistence harvest activities of these communities. Building roads into the National Petroleum Reserve – Alaska, with potential public access into Nuiqsut’s traditional subsistence range, would have high impacts as residents would be likely to avoid hunting in areas with permanent facilities, and would increase competition for subsistence resources with non-locals.

Conclusion

Exploration and development activities on the North Slope have greatly impacted subsistence activities, as noted during public scoping testimony. In the Planning Area, exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, and furbearers, affecting subsistence users in Nuiqsut, Atqasuk, Barrow, and Anaktuvuk Pass. Subsistence hunters traveling in nearly every direction from Nuiqsut would have to pass through some kind of development en route to subsistence harvest areas. Iñupiat hunters are reluctant to use firearms near oil production facilities and pipelines, so subsistence users would be unlikely to harvest subsistence resources in these areas. Aircraft have interfered with hunts by scaring game away from hunters, and the increase in air traffic by fixed-wing aircraft and helicopters would make this worse and over a much greater area if development goes forward. This issue has been raised several times by residents of Nuiqsut, who have also noted that oil and gas development is impacting traditional use areas and their ability to pass on knowledge of subsistence resources in these area, and use of these resources, to their children.

Development along the north side of Teshekpuk Lake, outside the area closed to leasing, could deflect or divert caribou hunted in and near the area by Nuiqsut, Barrow, and Atqasuk residents in the summer and winter (SRBA 2003b). Numbers of animals available for harvest could be reduced through the slow destruction of species by habitat loss, predation, climate change, and disease. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas further from the communities would require increased effort, risk, and cost on the part of subsistence users. Increasing the areas open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence harvest efforts in the undeveloped areas and increasing the potential for conflict over harvest areas within a community.

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses if warming trends continues as predicted (NRC 2003, ACIA 2004). Every community in the Arctic is potentially affected by the anticipated climactic shift and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of Nuiqsut, Atqasuk, Barrow, and Anaktuvuk Pass. If the loss of permafrost, and conditions beneficial to the maintenance of permafrost, arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of fresh water, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their population, shifting the population to places with better subsistence hunting and causing a loss or dispersal of community (NRC 2003, ACIA 2004).

4.7.7.13 Sociocultural Systems

The Iñupiat have developed sociocultural systems, including settlement patterns, kinship, leadership institutions, and cultural values concerning relationships with the land, as tools for successfully adapting to their Arctic environment. The following discussion addresses key events (past, present, and reasonably foreseeable future) and the impacts that these key events have had on sociocultural systems over time. This discussion focuses on sociocultural cumulative effects primarily involving changes in cultural values and social organization.

Past Effects and Their Accumulation

Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures (e.g., commercial whaling, trapping, reindeer herding, military construction, oil and gas exploration and development), and regulatory actions (e.g., state and federal regulations and International Whaling Commission quotas). (See Section 3.4.2.3 [Traditional Iñupiat Settlement Patterns and Subsistence Use Areas] and Appendix J.5 [Traditional Iñupiat Settelement Patterns and Subsistence Use Areas] for further discussions of these interactions and external pressures.) Adaptations to these external pressures resulted in intensified use of specific resources (e.g., bowhead whales, caribou, and furbearers). Commercial whaling north of the Bering Strait began and ended in approximately 60 years, and introduced a number of impacts to the people and resources of the North Slope such as disease, the introduction of new foodstuffs (e.g., flour, sugar, coffee, and tea), the increased availability of alcohol and tobacco, ongoing efforts at acculturation of the Iñupiat through missions and government schools, and efforts to centralize and make sedentary the highly mobile Iñupiat populations. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase newly introduced technological innovations to support subsistence activities (e.g., firearms, traps, boat motors, snowmachines). Missionaries arrived in the latter quarter of the 19th century to proselytize among the Iñupiat, operate federally-funded schools for the education and indoctrination of Iñupiat youth, provide some level of medical care, administer reindeer herding and other social experiments, and care for orphans whose parents had died in epidemics and accidents. The missionaries considered these efforts as necessary to mitigate the impacts of commercial whaling and prolonged contact with Euroamericans.

Commercial whaling ended by 1910, leaving whale numbers, as well as the Iñupiat population, depleted, and possibly resulted in the decreased availability of other subsistence species (e.g. caribou, moose, seals) and the extirpation of others (e.g. muskox). Fur trading became the main economic pursuit capable of earning the money needed to purchase American goods, such as sugar, tea, tobacco, flour, coffee, and lard, demanded by the Iñupiat. The Iñupiat, whose population was further devastated by the 1918 influenza epidemic, dispersed along the coasts and rivers, pursuing furs and a subsistence way of life until the Great Depression drove fur prices so low that fur trapping was no longer a viable pursuit. Subsistence whaling continued as a practice and as the center of social and political organization on the North Slope, and as the populations of whales and Iñupiat gradually recovered in the 20th century, resettled communities began to field discreet bowhead whale crews (e.g., Nuiqsut and Kaktovik).

With the establishment of the Naval Petroleum Reserve – Alaska in 1923, some initial exploration took place along the North Slope, but oil exploration and development did not commence fully until 1944, when the U.S. Navy and its contractors arrived to intensively explore and drill in the reserve. Following World War II, the U.S. Army constructed DEW-line sites and White Alice Communications System sites on the North Slope, often atop established Iñupiat camps and use areas, and North Slope residents were no longer allowed to hunt at these locations. In the late 1940s, the Bureau of Indian Affairs required families to relocate to population centers (e.g., Barrow, Anaktuvuk Pass) so that children could attend school. In addition, construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Iñupiat harvesters and their families often returned to traditional harvest areas seasonally, and in some cases those without school-aged children never left the traditional areas. In the early 1970s, following the passage of ANCSA, many traditional use areas and former villages were permanently resettled (e.g., Nuiqsut, Atqasuk, Kaktovik, and Point Lay).

By the mid-20th century, Iñupiat settlement patterns had changed significantly. The population became centralized into a few communities, when they previously had been spread in small family-based units across the North Slope sea coast, river banks, and lake shores, and only gathered into centralized locations for temporary, communal hunts (e.g. whales, caribou, molting birds), trading, and festivals. As the market economy and the need for cash for subsistence and survival have expanded, technological means for maintaining connections to the land have moderated the effects of gradually encroaching development along the North Slope. The limits of technology in mitigating the impacts of sedentism and oil development on subsistence activities have been reached. Few areas are out of reach for those with the wherewithal to purchase, maintain, and fuel the high-tech transportation equipment needed to access those areas. However, the expense of subsistence equipment and pursuing subsistence resources, time spent preparing for and on subsistence harvests, and wear and tear on subsistence equipment, restrict the ability of subsistence users to harvest adequate quantities in times of resource scarcity.

The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision given the lack of baseline data. As stated in Section 4.3.13 (Sociocultural Systems), public testimony indicates that a relationship exists between oil and gas development and social stress or well-being (Ahtuangaruak 1997). However, few data exist to support the correlation between oil and gas development and social stress. One example of a study that is being conducted to explore this relationship is the MMS sponsored study that will analyze NSB residents' observations and perceptions about effects from past, present, and future oil industry activities and other forces of modernity on their lives and subsistence whale hunting activities (EDAW in prep). In addition, the NSB has submitted a grant request to the State of Alaska for a study of the cultural, social, and economic impacts to National Petroleum Reserve – Alaska subsistence communities resulting from current Arctic oil and gas exploration and production. The North Slope Science Initiative, now in the planning stages, could also affect scientific research projects (Argonne National Laboratory 2004). Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts. Stress on North Slope sociocultural systems, which is generally underreported and inadequately documented, includes residents inability to access traditional use areas, threats to resources/lifeways and to spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a major oil spill, and its effects on bowhead whales and other marine mammals, fish, and wildlife, is of great concern to residents, although no such spill has occurred recently on the North Slope. These stresses accumulate because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion (NRC 2003).

Despite effects to sociocultural systems by oil and gas development, what has remained constant over time is the centralization of leadership with whaling captains and their wives, a continued cultural and nutritional dependence on and desire for subsistence foods, a continued reliance on sharing and kinship, a continued connection to family camps and land use areas, and the desire to have control over their communities' present and future. Whaling captains often are in positions of power in city, borough, and other institutions, and the institutions conform to the Iñupiat model of leadership and process. Subsistence foods are important for their nutritional value and their relatively low costs to the community, but most of all for the continued maintenance of the network of human and animal relationships, Iñupiat identity, and the activity of hunting, processing, and sharing as an outlet for individual social stress and a means of reducing community stresses. The desire to have some control over the harvest areas they depend upon, and the stress resulting from development and activities that conflict with their values with no recourse, is a significant stressor to individuals and communities. Some of these conflicts can be mitigated, as in the case of oil and whaler's agreements. Conflicts that are perceived to pit the Iñupiat against agencies and corporations contribute to feelings of futility, powerlessness, and despair, and when coupled with subsistence harvest shortfalls failures, pervasive unemployment, overcrowding, and other issues could result in significant and serious sociocultural consequences (IAI 1990). In the event that whaling quotas were reduced, whales were deflected offshore to avoid marine and air traffic and noise, or a significant oil spill occurred, whaling could be reduced or stopped, undermining the primary structure of social organization, traditional authority, and political power in the communities. As stated in Section 4.3.13 (Sociocultural Systems), NSB institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry and the IWC to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. “Oil-Whaler Agreements” have lessened the impact of seismic and other industry operations on subsistence bowhead whale hunting at Cross Island (NRC 2003).

The encroachment of oil production facilities and infrastructure into areas formerly used for subsistence by the Iñupiat increases the difficulties faced by subsistence users in trying to provide culturally valued foods for their extended families. This encroachment includes the permanent oil infrastructure to the east, north, and west of Nuiqsut, as well as the winter exploratory drilling and seismic testing in Inigok and other staging areas. The cycle of oil exploration, development, and production activities, as it is conducted both offshore and onshore, has contributed to harvest shortfalls, a loss of cultural privacy, and challenge to traditional Iñupiat values. Frustration stemming from the inability to provide for the extended family or exercise control over external factors further stresses people who are exposed to these problems. Rosemary Ahtuangaruak, former mayor of Nuiqsut, testified in the 2001 hearings held for the Liberty project, the following:

> One of the biggest issues that affects our community is the loss of control. In addition to the loss of subsistence opportunities, the major severe impacts result from the petroleum development in other areas of the Arctic. It is the lack of control over these events experienced by the village. Nuiqsut residents state they are the last to find out what's happening to them. They are never asked or generally considered about the pattern or course of the industry's development. They are merely informed after major decisions are in place. They would not spend the money making these studies if they were not planning to develop them. So it’s a moot issue, after the fact. You're coming for the meeting, but you're already spending the money because you know this project is happening. This perception causes enormous social stress and tension. It is reflected in the increased community social ills, such as the alcoholism, the domestic violence, and the drug abuse. Thus, existing and potential activities further exacerbate and destabilize stress and tension resulting from almost 20 years of petroleum activities in the region. And since development would complete the pattern surrounding our traditional whaling site, it poses the most significant and long-term adverse social and cultural impacts of all the development of the North Slope, the potential for permanent reduction and/or loss of subsistence reserves, and thus, the viability of the Iñupiat way of life.

In response to these types of social disruptions, the NSB, Alaska Eskimo Whaling Commission, regional and tribal governments, and village corporations have instituted efforts to foster and protect Iñupiat traditions. The BLM Subsistence Advisory Panel is tasked with investigating conflicts between subsistence activities and oil and gas development, and making recommendations for the lessee and the BLM for resolution to protect sociocultural values. Health and social services programs have tried to respond to alcohol and drug problems with treatment programs and shelters for abused spouses and families of abused spouses (USDOI BLM 2004c). Effective responses to other health issues, such as asthma, which is attributed to exposure to increased pollution from oil field operations, in addition to a background of cold weather and other injuries and illnesses, suffer from funding shortages. Rosemary Ahtuangaruak testified the following during scoping for the *Alpine Satellite Development Plan EIS* (USDOI BLM 2004c):

> When I started as a health aide in 1985 I had one asthma patient. By the time I went to the University of Washington for my physician assistant certificate in 1989, I had 20 to 25. When I came back in ‘91, there were 35. When I quit in 2000, there were over 60. The village make-up has not changed; it is still mostly Inupiaq. What was contributing, the most overwhelming issue, was that oil development around the community had increased and gotten closer. The worst nights

> on call were nights with many natural gas flares occurring. We could see it in the flares or in the fields around us. They release particles and they travel to us. The chance of an inversion will affect us. An inversion is a bowl-like air trap with cold air trapped by warm air. Increased concentrations of particulate matter occurs during these episodes.

Summary of Past Effects and Their Accumulation

Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures, and regulatory actions. By the mid-20th century, Iñupiat settlement patterns had changed significantly. The population became centralized into a few communities, when they previously had been spread in small family-based units across the North Slope. The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision given the lack of baseline data. Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts. Stress on North Slope sociocultural systems includes residents inability to access traditional use areas, threats to resources/lifeways and to spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a major oil spill, and its effects on bowhead whales and other marine mammals, fish, and wildlife, is of great concern to residents, although no such spill has occurred recently on the North Slope. These stresses accumulate because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion.

Future Effects and Their Accumulation

Continuing oil and gas leasing and development, as well as on-going changes in the Arctic climate, will have impacts on Iñupiat sociocultural systems in the foreseeable future. Development is currently being considered for the northeast corner of the Planning Area (Alpine Satellite Development), and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development, as stated by noted elder Ruth Nukapigak (1982) and others in the community. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization could potentially occur as a result of changes in population, employment, subsistence harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities could potentially result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities.

The abandonment of oil fields and the related loss of revenue would no doubt have serious effects on the entire state of Alaska. However, the collapse of commercial enterprise is seen as inevitable and is common over the history of the Iñupiat. Commercial whaling served the same markets as petrochemicals do today, and the Iñupiat survived by returning to the land. Fur trapping collapsed and the Iñupiat people adapted. The Iñupiat are at less risk from the decline of industry than they are in the face of an expanding and unchecked industry. In the event of oil field abandonment, the Iñupiat would likely be employed to assist in the removal and demobilization of the infrastructure and continue with their subsistence pursuits, possibly forming more camps or new communities on the grounds of older communities. Ideally, education would be delivered using home schooling through electronic means, a process currently in its early stages today. Less than 10 percent of Iñupiat history has proceeded in contact with Europeans and Americans, and in those 200 years they have maintained their unique cultural identity as a people throughout the Arctic.

Not all sociocultural changes are negative. Positive impacts come from higher incomes, better health care, improved housing, and improved infrastructure and educational facilities, although these impacts may primarily benefit younger individuals who are generally more accepting of change (NRC 2003). Iñupiat culture as an adaptive mechanism is a powerful means of self-directed social, political, and cultural change capable of sustaining the Iñupiat through adverse circumstances as it has for centuries guided them through resource shortages, inter- and intra-group social conflicts, and environmental changes.

Global Climate Change

Climate change could cause changes to the environment and habitats of the North Slope that could affect subsistence resources and users, as discussed in Section 4.7.7.12 (Subsistence). Changes in climate regimes could result in changes to species diversity, numbers and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape. If the landscape becomes less hospitable for human occupation, people may move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. Community stresses could increase as a result, and traditional knowledge of the landscape, environment, and resources would be devalued if conditions change rapidly, reducing the influence of experienced elders in the communities. Reduced levels of stratospheric ozone could continue to allow higher levels of UV exposure to northern peoples, lowering immune system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA 2004).

Contribution of Amendment Alternatives to Cumulative Effects

As noted above, continuing oil and gas leasing and development will have impacts on Iñupiat sociocultural systems in the foreseeable future. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and could be encircled by development. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization could potentially occur as a result of changes in population, employment, subsistence harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities could potentially result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities.

These effects would be greatest under Alternative C, not only because it would result in a greater amount of surface disturbance (as many as 2,000 acres) that the other alternatives (1,570 acres for Alternative B, 1,100 acres for the final Preferred Alternative, and 500 acres for the No Action Alternative), but the entire Planning Area would be available for oil and gas leasing and development. However, the amount of wealth, including income from royalties, taxes, and jobs, generated by oil and gas activity and available to residents of the North Slope would be approximately two- to nine-fold greater under Alternative C than the other alternatives. The effects on wealth and subsistence resources would be least under Alternative A, while the effects on wealth and subsistence resources under Alternative B and the final Preferred Alternative would be between the No Action Alternative and Alternative C.

Conclusion

Both additive and synergistic impacts to sociocultural characteristics of North Slope communities are associated with oil and gas exploration and development on the North Slope. Because of the primary dependence of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut residents on the subsistence caribou harvest from CAH, TLH, and WAH caribou, bowhead whaling offshore, and continued healthy fish, cumulative effects could potentially chronically disrupt sociocultural systems in the community, particularly in the case of bowhead whaling, around which the sociocultural system is based. Caribou hunting provides food and materials that support whaling. Seal hunting provides skins for Barrow’s skin boat whaling in the spring and supplies meat for food. Fishing and bird hunting provide meat and fish for whalers as well as for the festivals, *Nalukataq* and *Kivgiq*, associated with whaling. These festivals are important social activities that unify the communities, reunite families, and maintain the continuity of the present with past practice and tradition.

Effects from industrial activities (e.g., noise, light, and chemical pollution), changes in human population and employment, and the accompanying changes in subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but they would not be expected to displace sociocultural institutions, social organization, or sociocultural systems. Funding cuts and reduced wage earnings would not likely reduce subsistence uses, but may require changes in seasonal round and longer periods of travel to get to subsistence harvest areas; however, these would more than likely resemble the pre-1950 pattern of residence and travel, and technology is available that could facilitate education services delivery via electronic means.

Health issues caused by persistent and short-term pollution could shorten life spans of elders, who are the key repositories of traditional and cultural knowledge in the communities. Health issues from increased injuries as a result of the need to travel further over rough terrain to support families with subsistence foods could reduce community involvement with employment, tax the community health infrastructure, encourage outmigration, and lead to increases in substance abuse and depression in those no longer able to participate in subsistence activities. Cuts in funding for services would increase the severity of the problem of delivery of health services as well as maintaining health and hygiene infrastructure (e.g. fresh water, sewers, and washeteria).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses as well as impacts to population, employment, and local infrastructure. The termination of oil activity could result in the outmigration of non-Iñupiat people from the North Slope, along with some Iñupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally-constrained, post-oil production circumstance. If subsistence livelihoods are disrupted, Iñupiat communities could face increased poverty, drug and alcohol abuse, and other social problems resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on non-subsistence foods (Langdon 1995, Peterson and Johnson 1995, USGCRP 2000, IPCC 2001). As stated by Parson et al. (2001), "It is possible that projected climate change will overwhelm the available responses." It is also realistic to expect that some general assistance could be found to mitigate the losses of nutrition, health, and income from diminished subsistence resources, but such assistance would likely have little effect in mitigating the associated social and cultural impacts.

4.7.7.14 Environmental Justice

Activities that impact subsistence resources and access to those resources could have a disproportionately high impact on minority and low-income communities. Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area that would likely be most affected by activities in the Planning Area under the four alternatives, and activities associated with other projects on the North Slope. Environmental justice effects on Iñupiat Natives have occurred in the past from non-oil and gas, and from oil and gas impacts on their subsistence resources and harvest practices. Causes of cumulative effects would include commercial harvest of fish, oil spills, noise and traffic disturbance, and disturbance from construction activities associated with exploration and development on the North Slope. In addition, habitat reduction and increased local population pressure continue to challenge the survival of many traditional subsistence practices. It is expected that cumulative effects to subsistence resources, harvest practices, and sociocultural patterns from noise, disturbance, and oil spills would primarily impact the Iñupiat communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut within the NSB. The following sections discuss some of these impacts to Iñupiat Natives that have occurred in the past and could occur in the future. Since cumulative effects to subsistence resources have been discussed in much detail in earlier sections, the reader is encouraged to read earlier cumulative effects sections on vegetation, fish, birds, mammals, endangered and threatened species, and subsistence (Sections 4.7.7.5, 4.7.7.7, 4.7.7.8, 4.7.7.9, 4.7.7.10, and 4.7.7.12).

Past Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, effects to the sociocultural and subsistence activities of Native communities were primarily the result of natural factors, including weather and natural population cycles of subsistence animals. As discussed in Section 4.7.7.12 (Subsistence), the advent of commercial whaling in the Pacific Ocean and subsequent Euroamerican influence had a profound affect on the people and resources of the North Slope. Effects on the Iñupiat of the North Slope included disease; introduction of new foodstuffs, including flour, sugar, coffee, and tea; the increased availability of alcohol and tobacco; ongoing efforts at acculturation of the Iñupiat through missions and government schools; and efforts to centralize and make sedentary the highly mobile populations of Iñupiat. The failure of commercial whaling by 1910 coincided with a depletion in the number of whales available for harvest, making the ongoing subsistence harvest difficult for the Iñupiat remaining along the Arctic coast. Further complicating subsistence whale harvest was a decrease in the Iñupiat population due to disease, accidents, and poor health care. Iñupiat and whale populations gradually recovered during the 20th century. Some whale populations, however, including bowhead whales, are still depressed from historic levels. Following a reduced presence of Euroamericans in the beginning of the 20th century, due to the collapse of commercial whaling, the Iñupiat returned to their highly dispersed way of life, with additional emphasis on fur trapping and reindeer herding as a source of money to buy those Euroamerican goods they desired.

Oil and gas exploration from 1920 to 1968 brought changes to the Iñupiat people. By 1950, the Bureau of Indian Affairs was requiring families with school age children to relocate to population centers (e.g., Barrow) so that the children could attend school. Construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Children were sent outside to boarding schools, including Chemawa in Oregon and Mt. Edgecumbe in Sitka. The children that returned from these boarding schools often became spokespeople for the community and interposed themselves between the forces of development and the conservation of traditional ways of life.

During the mid-20th century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope. North Slope residents were no longer allowed to hunt near these locations, all of which were situated at or near important subsistence or residence sites. Operation of these sites by the military, and later by contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, which led to avoidance of these areas by subsistence harvesters concerned about chemical contamination. Postwar oil exploration and the sustained contact with Euroamericans, brought by activities associated with oil and the Cold War, resulted in additive impacts on subsistence resources, harvest patterns, and users. In addition, development associated with villages on the North Slope impacted subsistence resources. These activities cumulatively resulted in the loss of approximately 2,500 acres of habitat for subsistence species.

The most intense oil and gas development activity, and increased impacts to subsistence activities, occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). This activity has resulted in the cumulative direct loss and indirect loss of approximately 13,000 acres and 21,000 acres of habitat, respectively, for subsistence species, and higher levels of disturbance that can impact species health, reproduction, and survivorship.

As discussed in Section 4.7.7.12 (Subsistence), North Slope residents have noted the decline of fish populations caused by seismic activities, the diversion of caribou from traditional migration routes and calving areas caused by an increased number of low flying aircraft, the disruption of caribou movements by low pipelines, and the ending of use of traditional harvest areas due to the avoidance of industrial areas by hunters. Oil and gas development in the Prudhoe Bay and Kuparuk areas discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (see Appendix J; Section J.10.4 and Maps J-7, J-8, J-9, J-10, J-11, J-12, and J-13). Additionally, bowhead whaling quotas instituted by the International Whaling Commission resulted in the establishment of the Alaska Eskimo Whaling Commission. Some residents were profoundly concerned about impacts to marine resources, and so opposed any oil development in the marine environment.

Impacts to subsistence cased by the seismic exploration programs on the North Slope have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blamed this activity for declines in fish numbers in the vast number of interconnected lakes and streams used by subsistence fishermen. Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast National Petroleum Reserve – Alaska meetings a consensus opinion among Iñupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in.

In the past, oil and gas activities have deterred subsistence users from using their traditional subsistence use areas. The continued expansion of this activity across the ACP from Prudhoe Bay westward could increase the area considered off-limits by resource users, deflect or divert important subsistence resources from their normal routes, and require users to travel farther to harvest subsistence foods (IAI 1990a). The continued increase in developed area would reduce the amount of suitable lands available for Nuiqsut residents to harvest necessary subsistence resources away from oil and gas facilities.

Summary of Past Effects and Their Accumulation

Euroamerican presence, commercial whaling, and non-oil and gas development and oil and gas exploration and development have had cumulative impacts to Iñupiat culture and to fish and wildlife used for subsistence. Euroamerican presence has impacted the Iñupiat through disease and other ills. Commercial whaling nearly decimated whale stocks in the Chukchi and Beaufort seas; bowhead whale populations, though recovering, remain nearly 80 percent below levels in the 1800s. Non-oil and gas development associated with military, residential, and commercial development have directly impacted several thousand acres of fish and wildlife habitat and have also indirectly affected habitat and animal behavior effects that have accumulated and persist today. Oil and gas exploration and development conducted by the federal government and industry have directly impacted the habitat use and behavior of subsistence species that also persists today. These effects have disrupted subsistence livelihoods, and may, in part, account for some of the social problems seen in the villages today.

Future Effects and Their Accumulation

The Iñupiat people will be affected by future disturbances to key subsistence species that leads to disruption, displacement, or long-term changes in species' populations. Expanded oil and gas development on the North Slope, on both federal and state leases, would increase disturbance effects to subsistence species and harvest patterns. While each individual project would likely be a small incremental increase, the cumulative effect would eventually become more and more repressive to the subsistence lifestyle. As discussed for other resource areas, 5,000 or more acres could be directly impacted from oil and gas development associated with activities in the National Petroleum Reserve – Alaska and elsewhere on the North Slope in the future. Indirect impacts to soil, water, and vegetation could be three to four times the amount of direct disturbance.

In addition to direct and indirect loss of habitat that can affect subsistence species, noise and other disturbance associated with oil and gas development would divert, deflect, and disturb subsistence species, potentially having population-level effects that would accumulate. Oil and gas development could also affect subsistence harvest by causing subsistence hunters to avoid certain areas because of concerns about firearm safety, and perhaps for aesthetic reasons. Although the North Slope still has huge amount of area that is relatively undisturbed, the general subsistence-hunting environment continues to change in response to increased development. During the past several decades, populations of caribou, bowhead whales, and other wildlife and fish have generally increased, to the benefit of subsistence hunters, despite habitat, disturbance, and other effects that have accumulated. However, there is no certainty that these trends would continue into the future, especially as the effects of global climate change on the Arctic environment become more pronounced.

Oil-spill contamination of subsistence foods is another important concern regarding potential effects on Native health. Although some contamination remains on the North Slope from past military and government activities, and from the early days of oil and gas development, the effects on subsistence species and users are minor. Efforts to clean up old disposal sites in the past have helped to reduce the effects that would accumulate with spill effects in the future. Human health could be threatened in areas affected by oil spills, but these risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuation of people and avoidance of marine and terrestrial foods that might be affected. In the unlikely event that a large spill were to occur and contaminate essential whaling areas, major effects to subsistence resources could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices. Such impacts would have a disproportionately high affect on Alaska Natives. Contamination of subsistence foods by oil spills would potentially affect Native health and health and survivorship of subsistence species.

Transportation facilities and activities would also contribute to cumulative effects to subsistence resources and, consequently, to the Native population. A new permanent road connection from TAPS to Nuiqsut and the National Petroleum Reserve – Alaska would also facilitate petroleum development, and could provide an additional travel route for the public to the North Slope. This could encourage more hunters and other visitors to travel to the Planning Area, increasing the potential for conflicts between subsistence users and other users of fish and wildlife resources.

It is acknowledged that cumulative sociocultural impacts have occurred on the North Slope and that Iñupiat culture has undergone a noticeable change. The influx of money from wage employment has added many benefits and raised the standard of living, but has also given rise to an array of social pathologies, including increased alcoholism, as discussed in Section 4.7.7.13, Sociocultural Systems.

Global Climate Change

It is difficult to determine exactly how global climate change figures into the cumulative mix. It is expected that global climate change affects animal populations, but the type, location, and magnitude of effects appears to be the subject of some disagreement. Regardless of exactly what those effects would be, changes to the numbers of animals or patterns of animal behavior would affect subsistence harvests, and the effects would thus be interactive with those of other North Slope activities. Whether global climate change would exacerbate effects on subsistence species or ameliorate them remains a subject for speculation.

Contribution of Amendment Alternatives to Cumulative Effects

Under the cumulative case, currently planned development in the Planning Area and winter exploration throughout the entire area would continue. Seismic exploration would occur in winter and would include the drilling of exploratory and delineation wells in areas not excluded by buffers. Exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, and furbearers, affecting subsistence users in Nuiqsut and to a lesser extent in Atqasuk, Barrow, and Anaktuvuk Pass. If permanent development is pursued in areas newly opened to exploration and leasing under alternatives B, C, and the final Preferred Alternative, Iñupiat users could no longer utilize an area from 5 miles to 25 miles around those facilities for subsistence uses. The areas that would be potentially off-limits could represent a majority of the portion of the subsistence range that is presently undeveloped, and includes areas of great traditional and historic significance and key habitat areas for several crucial subsistence species.

Allowing leasing and development of all or portions of the Teshekpuk Lake Special Area under the action alternatives would dramatically reduce the amount of undisturbed habitat to caribou, waterfowl, fish, and other subsistence species. These effects to subsistence species would be greatest under Alternative C. Effects to subsistence species would be similar under Alternative B and the final Preferred Alternative. Although much of the northeastern portion of the Planning Area would be closed to leasing under Alternative B, the amount of development proposed under this alternative would be about 20 percent greater than for the final Preferred Alternative. Teshekpuk Lake would be deferred from leasing under the final Preferred Alternative, protecting waterfowl and other subsistence species that use the lake. In addition, NSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to cultural resources. Under the No Action Alternative, 600,000 acres associated with Teshekpuk Lake Special Area would be closed to leasing.

Conclusion

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area that would likely be affected by exploration and development in the Planning Area and other past, present, and reasonably foreseeable projects on the North Slope. Environmental justice effects on Iñupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects would increase the effects on subsistence resources and harvest practices.

Potential effects would focus on the Iñupiat communities of Point Lay, Wainwright, Barrow, Atqasuk, and Nuiqsut within the NSB. Based on potential cumulative, long-term displacement and/or functional loss of CAH, TLH, and WAH caribou habitat over the life of the Northeast National Petroleum Reserve – Alaska oil and gas lease sales, and from other oil and gas developments on the North Slope, this important subsistence resource could become less readily available or undesirable for use, or experience long-term population and productivity effects. Such impacts would disproportionately affect Alaska Natives. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development were to reduce the availability of resources or alter their distribution patterns.

Because the potential impacts of climate change on marine and terrestrial ecosystems in the Arctic would cause impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic would be expected to experience disproportionate, environmental and health effects.

In the unlikely event that a large spill were to occur and contaminate essential whaling areas, major effects to subsistence resources could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices. Such impacts would have a disproportionately high affect on Alaska Natives. Contamination of subsistence foods by oil spills would potentially affect Native health.

It is expected that the cumulative effects on subsistence resources and subsistence harvests in the Planning Area would be expected to be mitigated substantially, though not eliminated, by proposed ROPs and lease stipulations.

4.7.7.15 Coastal Zone Management

Activities associated with cumulative effects on the North Slope include those occurring under the amendment alternatives, oil and gas development in the Northwest National Petroleum Reserve – Alaska, federal and state offshore oil development, state onshore oil development, and oil and gas transportation. The activities associated with exploration, facility construction, operation and maintenance, and oil spills are the most important elements for the cumulative analysis because of their potential disturbance and habitat impacts.

While the Planning Area is technically outside the coastal zone, it is within the NSB. The NSB applies its Comprehensive Plan policies and CMP policies to all developments occurring on private, federal, and state lands; however, the NSB's jurisdiction is the subject of litigation. Oil and gas development activities could include portions of road/pipeline corridors, including the offshore portions (such as inlets and bays) within the NSB boundary. Development activities occurring adjacent to the Colville and Ikpikpuk rivers that could affect coastal resources or uses, including activities described in exploration plans and development and production plans, could be subject to the statewide standards and NSB district policies of the ACMP. Policies of the ACMP are examined herein for potential conflicts with effects from oil and gas exploration or development activities. Potential effects are summarized as succinctly as possible. Additional information is contained in the Coastal Zone Management section of the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998).

Although all federal lands, including those within the Planning Area, are categorically defined as being outside of the coastal zone, all federal activities and federally-permitted activities must be reviewed for consistency with coastal management programs. Therefore, onshore activities within the Planning Area and some offshore activities identified under the alternatives should be assessed against the Alaska CMP, including the NSB CMP.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities on the North Slope are subject to all applicable lease stipulations listed in the 1998 Northeast IAP/EIS ROD (for Planning Area), as well as any other federal, state, or NSB regulations that pertain to the activities in question (for Planning Area and remainder of North Slope). These activities include aircraft use for point-to-point transport, and wildlife and other aerial surveys; ground activities such as seismic surveys, resource inventories for paleontological and cultural excavations, research and recreational camps, and overland moves; and guided hunting and river float parties on the Colville River from the headwaters to below Umiat. Hazardous and solid waste spills, and removal and remediation have occurred at abandoned drill sites. Oil spills have occurred at fuel storage sites and camps, but the size of these spills have been small. Clean-up activities have not greatly disturbed subsistence harvest activities or the surrounding environment. Development associated with past military and other government activities, and from growth of villages, has had effects on subsistence species and subsistence users that were minor, but still persist today.

Oil and Gas Exploration and Development Activities

Coastal Development and Access (11 AAC 112.200 and 11 AAC 112.220). Water dependency is a prime criterion for development along the shoreline. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine, lakeshore, and river waterfronts. Access to coastal areas by Iñupiat Natives has been restricted at Prudhoe Bay and other coastal facilities for the safety of the Natives and for protection of oil field infrastructure. A concern brought up during scoping for this amendment was the inability of some Natives to visit historic cabins and campsites used by ancestors at Prudhoe Bay. The loss of access to some coastal areas on the North Slope is an effect that persists today.

Energy Facilities (11 AAC 112.230). The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. Other criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). The NSB CMP also requires that transportation facilities and utilities must be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[t] and NSBMC 19.70.050.K.6).

In the past, facilities have generally been sited where oil resources were most easily accessed. As a result, areas with high biological productivity, especially coastal wetlands, have been impacted by oil and gas development. The loss of this productivity persists today. Recent technology that reduces the size of the gravel footprint needed for development and production, and encourages directional drilling, have allowed oil and gas developers to site facilities in areas with lower biological productivity.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280). These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

As discussed for bird and mammal resources, roads and pipelines have altered drainage patterns, disrupted wildlife movements, habitat use, and reproductive success, especially for caribou, and have restricted traditional access into important subsistence areas (NRC 2003). Over 9,000 acres have been directly impacted by gravel roads and pads, and alteration in drainage patterns has occurred on nearly twice that many acres. Caribou avoid, or are hesitant to cross roads, during migrations to foraging and insect-relief habitats (see Section 4.7.7.9; Mammals). In the past, pipelines were often placed low to the ground, and even now, pipeline height does not have to exceed 5 feet within the Planning Area. Pipelines that are close to the ground have acted as a physical barrier to caribou movement, and to subsistence hunters on snowmachines or other vehicles.

Sand and Gravel Extraction (11 AAC 112.260). Extraction of sand and gravel is a major concern on the North Slope. Gravel resources are needed for construction of pads, roadbeds, berms, causeways, and docks to protect the tundra. The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need.

Through 2001, over 6,300 acres had been impacted for gravel mines on the North Slope; prior to 1968, only 24 acres had been impacted (NRC 2003). Eighty percent of these mines were located in rivers, the remainder in tundra. As discussed in Section 4.7.7.7 (Fish Resources), only about 1,800 acres of mine disturbance persists today, evenly divided between tundra and river sites. Many of the river sites were filled in when the river channel shifted, while others have been reclaimed to provide deepwater habitat, which is important to wintering fish. Thus, most of the effects associated with past gravel mines have been compensated for through development of new fish habitat.

Subsistence (11 AAC 112.270). The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. However, access to subsistence resources, and subsistence hunting and resource use have been affected by oil and gas development, as discussed in Section 4.7.7.12 (Subsistence). Subsistence resource availability has been effected by direct and indirect loss of habitat and from disturbance to animals from pipelines, structures, support-bases, pump stations, and roads.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts. Iñupiat Natives tend to avoid hunting and fishing near oil facilities, and as discussed in Appendix J, they travel further to reach subsistence resources than occurred in the past. These effects persist today.

Habitats (11 AAC 112.300). The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This policy is supported by an NSB CMP policy requiring that development be located, designed, and maintained in a manner that prevents substantial impacts on fish and wildlife and their habitats, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2).

Past activities in the Planning Area and on the North Slope have degraded habitat, as discussed under related plant and animal resource areas. In the context of the North Slope and ACP, the amount of habitat directly or indirectly harmed from oil and gas activities has been less than 1 percent, and most populations of fish and wildlife appear healthy and are stable or increasing. Caribou and bowhead whale, important subsistence species, have shown steady population gains during the past several decades (NRC 2003). Populations of brant and several species of shorebirds, however, are declining, although it is not known if the causes of the decline are related to activities on the North Slope, or from activities occurring on the migration or wintering grounds, or both. Some effects of oil and gas development have countervailing effects. For example, vegetation and soil are lost from gravel mines, but mines also provide important wintering habitat for fish and loafing habitat for birds.

Air, Land, and Water Quality (11 AAC 112.310). The air, land, and water quality standard of the ACMP incorporates, by reference, all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. Water quality can be affected by oil spills, deliberate discharges and emissions, and gravel operations.

As discussed in Section 4.7.7.1 (Air Quality), air quality on the North Slope meets NAAQS and air quality is relatively pristine. Arctic haze has occurred in the past, but the source of this haze appears to be pollutants from Europe and Asia. There have been minor effects to vegetation from air pollutants, but these effects are not likely to occur and persist at a level that would harm subsistence species.

Based on the history of military activities and oil and gas exploration and development on the North Slope, as discussed in Section 3.2.10 (Hazardous Materials), large amounts of hazardous material and waste have been dumped on the tundra, often onto the ground or into unlined storage facilities, and these materials have impacted local surface and groundwater sources. Much of this material was removed in the 1970s and early 1980s, and some cleanup continues today, although some effects from these actions likely persist today.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320). The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes. The NSB developed additional policies to ensure protection of its heritage. Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8).

As discussed in Section 4.7.7.11 (Cultural Resources), interest in the geology and archaeology of the North Slope began in earnest at the beginning of the 20th century, but access was generally limited to coastal or easily accessible areas (see Section 3.4.1.8; European/Euro-American Expansion, Exploration, and Ethnographic Research). Effects to cultural resources in the National Petroleum Reserve - Alaska have been occurring since 1923, when oil and gas exploration and mapping began with USGS surveys of the Reserve, assisted by Native guides. With the onset of the Cold War, military activity on the North Slope also affected cultural resources. During the 1950s, ground-disturbing activities associated with the rapid construction of the DEW-Line and WACS sites affected cultural resources. Continued and increasing amounts of oil and gas exploration and drilling across the North Slope further affected cultural resources and Native peoples' relationships with their ancestral homelands.

Following Alaska statehood in 1959, land selections were made by the state and federal governments, which did not include Native land ownership except as provided for under the Indian Allotment Act of 1906. No effort was made at that time to inventory, identify, record, or document Native land use or historic and archaeological sites as a result of these land selections. As a result of this lack of strong legal protection, oil development and production during this initial period severely impacted cultural resources and diminished some peoples' relationships with their individual and collective history.

The most intense oil and gas development activity occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). These developments occurred following the passage of the NHPA (1966) and NEPA (1969) that mandated the identification of cultural resources potentially affected by these developments and mitigation of the impacts. In addition, these developments resulted in the discovery of many previously undocumented cultural resources. In part, increased oil and gas exploration and development activity prompted the NSB to initiate the Traditional Land Use Inventory. In 1977 and 1978, an archaeological survey was conducted in select areas of the National Petroleum Reserve - Alaska. This survey resulted in the identification of 728 cultural resource sites in the Planning Area.

Summary of Past Effects and Their Accumulation

As most non-oil and gas development, and oil and gas development on the North Slope has occurred near the coastline, conflicts with the NSB and State of Alaska coastal zone management policies have occurred in the past. Specific issues include limits on access to coastal areas by Alaska Natives, disturbance to and deflection of caribou moving to insect-relief areas along the coast, loss of habitat, and loss of historical, cultural, and archaeological resources resulting from exploration and development along the coastline. Through consultation, conflicts between coastal zone management policies and proposed development that could occur in coastal areas have been reduced since implementation of coastal management policies.

Future Effects and Their Accumulation

The ACMP statewide standards and NSB enforceable policies that are relevant to the analysis of the alternatives for this amendment remain relevant for the cumulative case. Although the level of effects could increase for the cumulative case, the scenarios assumed for the analyses in this amendment would not be expected to conflict with the statewide standards or the district policies. Activities that would occur outside the boundaries of the National Petroleum Reserve - Alaska, but within the NSB (including the coastal zone), would require permitting and approval from the NSB before proceeding. Those activities would not be approved by the NSB if they conflicted with the coastal management program enforceable policies. In addition, the BLM would consult with the State of Alaska DNR regarding coastal zone consistency determination when a lease sale is proposed to ensure that the BLM is in compliance with the CZMA. Thus, effects would accumulate under coastal zone management in the future, but would not conflict with policies of the State of Alaska and Borough coastal zone management programs.

Coastal Development and Access (11 AAC 112.200 and 11 AAC 112.220)

The potential for Alaska Natives to be denied access to coastal areas would increase as more development occurs near the coast. However, the BLM proposes to implement Lease Stipulation K-6 (Coastal Areas) to prohibit or minimize development within ¾ of a mile of the coastline. This lease stipulation should ensure that the coastline remains relatively unspoiled and allows for Alaska Native access to coastal areas adjacent to the National Petroleum Reserve – Alaska.

Energy Facilities (11 AAC 112.230), Utility Routes and Facilities (11 AAC 112.240), Transportation Routes and Facilities (11 AAC 112.280)

The NSB CMP contains several additional policies related to transportation and utilities that may be relevant to this analysis. All but one of the policies are best-effort policies and subject to some flexibility if: 1) there is a substantial public need for the proposed use and activity; 2) all feasible and prudent alternatives have been rigorously explored and objectively evaluated; and 3) all feasible and prudent steps have been taken to avoid the effects the policy was intended to prevent. Transportation development, including pipelines, which obstructs wildlife migration is subject to the three conditions listed above (NSB CMP 2.4.5.1 [g] and NSBMC 19. 70.050.J. 7). The oil and gas industry, in consultation with federal, state, and local agencies, has implemented policies and management procedures to minimize impacts to caribou and other wildlife from pipelines and other linear facilities that would benefit wildlife in the future. These include the requirement that pipelines be a minimum of 5 feet above the ground, and that roads, pipelines, and other utility lines use a common corridor.

Sand and Gravel Extraction (11 AAC 112.260)

The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need.

Approximately 6,300 acres have been impacted by gravel mines on the North Slope (NRC 2003). Much of the gravel was obtained from gravel deposits within floodplains. But concerns arising from this practice prompted the USFWS to study the effects of floodplain gravel mining on the floodplains physical and biotic processes (Woodward-Clyde Consultants 1980). The study identified numerous examples of habitat modification, including increased channel braiding, loss of wintering areas, spreading of flow, and restriction of fish movements, such as fish mortality caused by stranding. The study also set forth guidelines for gravel mining to minimize floodplain damage (Joyce et al. 1980). In response to agency concerns, and the results of the USFWS study, new gravel mines have primarily been sited in upland sites since the 1980s. Few good sources of gravel have been identified in the Planning Area, although limited effort has been spent on identifying potential gravel sources within the Reserve. Future gravel sites would be sited in upland areas, and away from the coast, where feasible.

Subsistence (11 AAC 112.270)

Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if development were to reduce the availability of these resources or alter their distribution patterns. Activities that could affect subsistence resources and access include noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, supply efforts, and the unlikely event of a large oil spill and associated clean-up efforts. Of these, the unlikely event of a large spill is the only occurrence that could substantially interfere with access to subsistence resources. If a large spill were to occur and essential harvesting areas were contaminated, effects could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices.

The other impacting factors either would not be expected to have more than local, short-term impacts, or could be effectively addressed through the proposed suite of lease stipulations and ROPs. The proposed lease stipulations and ROPs, existing regulations and management practices, and future conditions placed on permits for future projects would serve to assure that the timing and monitoring of potential sources of disturbance would minimize conflicts with subsistence activities. Activities addressed for cumulative effects would not be likely to result in conflict with this statewide standard or with the district enforceable policies.

Habitats (11 AAC 112.300)

The effects of pipelines, roads, and facilities installation and construction are magnified in the cumulative case. However, the analyses indicate that the potential additive effects would not substantially alter or interfere with the habitats, species, and activities that these standards address. Cumulative effects are not anticipated to increase the potential for conflict with these statewide standards. Siting of energy facilities, transportation, and utilities outside the boundaries of the National Petroleum Reserve – Alaska (but within the boundaries of the NSB and the coastal zone) would require NSB permitting and approval. The NSB policies would be addressed through this approval process, and permitting would be dependent upon adherence to these policies.

Air, Land, and Water Quality (11 AAC 112.310)

As discussed in Section 4.7.7.1 (Air Quality), air quality on the North Slope meets NAAQS and air quality is relatively pristine. Arctic haze has occurred in the past, but the source of this haze appears to be pollutants from Europe and Asia. As oil production declines on the North Slope, and new air pollutant control technologies are implemented, the amount of air pollutants would continue to decrease from historic levels on the North Slope.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320)

Historic, prehistoric, and archaeological resources are nonrenewable, and displacement or contamination of these resources could affect the cultural and scientific values of the resource. The cumulative effects of oil and gas exploration and development within the Planning Area and across the North Slope are difficult to estimate given the scattered nature of historic, prehistoric, and archaeological resource deposits, their surface or near-surface contexts, and difficulty in predicting their location. As long as surveys and inventories were completed prior to exploration and development, the effects on these resources would be minimized. The accidental discovery or damage to sites, presently known or unknown, would to some extent damage those sites, but would also require measures to recover or record the remaining material, adding that information to the archaeological record of the North Slope.

The NHPA requires agencies, or their permittees, to complete a cultural resources survey before any undertaking occurs (i.e., a ground-disturbing activity, such as well drilling, construction of infrastructure or the construction of buried pipelines) on federal lands. The BLM's guidelines and policies require that all effects to any cultural resources identified during surveys must be mitigated to the satisfaction of the land manager and the SHPO. Lease stipulations and ROPs developed for the action alternatives would minimize or prohibit exploration and development activities near major rivers, reducing the likelihood of impacts to historic, prehistoric, and archaeological resources.

Global Climate Change

Rising temperatures are altering the Arctic coastline and changes are projected to continue during this century as a result of reduced sea ice, thawing permafrost, and sea-level rise (ACIA 2004). Thinner, less extensive sea ice creates more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along Arctic shores.

Rising sea level is very likely to inundate marshes and coastal plains, accelerate beach erosion, and force salt water into bays, rivers, and groundwater. Coastal regions with underlying permafrost are especially vulnerable to erosion as ice beneath the seabed and shoreline thaws from contact with warmer air and water. The projected increase in air and water temperature, reduction in sea ice, and increase in height and frequency of storm surges are expected to have a destabilizing effect on coastal permafrost, resulting in increased erosion.

In the Alaskan village of Nelson Lagoon, residents have built increasingly strong break walls along the shore, only to see them destroyed by increasingly violent coastal storms. The village of Shishmaref, located on an island just off the coast of northern Alaska and inhabited for 4,000 years, is now facing the prospect of evacuation. The coastline along the North Slope is receding approximately 8 feet a year, more rapidly than coastlines in other parts of the world. As this process continues, loss of cultural and paleontological, soil, vegetation, and habitat resources would accumulate and would be irreversible within our lifetimes.

Contribution of Amendment Alternatives to Cumulative Effects

Most of the coastal area, from Atigaru Point to the boundary with the Northwest National Petroleum Reserve – Alaska, would be closed to leasing under the No Action Alternative. Lease Stipulation K-6, Coastal Areas, requires that permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least ¾ mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within ¾ mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning (DEW)-Line sites, shall be considered. Use of existing sites within ¾ mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permitees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Association, and the NSB to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. Adherence to this lease stipulation should ensure that coastal resources are adequately protected. All federal activities and federally-permitted activities must be reviewed for consistency with coastal management programs. Therefore, onshore activities within the Planning Area and some offshore activities identified under the alternatives should be assessed against the Alaska CMP, including the NSB CMP.

Conclusion

Effects on access to subsistence hunting and subsistence resources would offer the greatest opportunity for conflict with the statewide standards and the NSB policies related to these concerns. Increase in noise and disturbance from cumulative oil development would be additive and could have localized, short-term effects on some subsistence resources and access to some resources. Noise and disruption could be effectively addressed through lease stipulations and ROPs, existing regulations and management practices, coordination, and future permitting processes including federal, state, and local processes as applicable. Federal regulations require and implement strict oil spill prevention standards, and a large spill would be considered unlikely. In addition, the lease stipulations and ROPs would effectively address prevention and response relative to small and large spills. Conflicts with statewide standards of the ACMP and the policies of the NSB are not inherent in the scenarios assumed for this amendment.

4.7.7.16 Recreational Resources

In addition to the impacts described under the alternative's analysis, cumulative effects to recreational resources would result from past and future activities and facilities that affect solitude, naturalness, or primitive/unconfined recreation. Short-term or transient loss of the area's naturalness and solitude from such impacts as green pads/trails and noise from aircraft and equipment would not be cumulative. Therefore, their contribution to the cumulative impacts would be "momentary."

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), noise from generators, aircraft, human presence, and associated activity would have had short-term impacts on the experience of solitude, naturalness, or primitive/unconfined recreation. Because all of these identified non-oil and gas activities would have been transitory and short term, the likelihood of recreationists encountering them in any given location in the 57 million acre North Slope or in the 4.6 million acre Planning Area is probably small, unless recreation activities were centered around villages or oil and gas facilities, or occurred along major rivers and coastal areas.

A longer-lasting impact would have been from green trails resulting from overland moves. Green trails were created by vehicles compacting snow and dead vegetative matter that in turn results in the greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They usually are difficult to recognize from the ground. Another impact along these trails that has occurred in the past is vegetation actually being damaged or broken or the tops of tussocks being scraped off. Though still relatively short term in nature, the linear nature of these trails emphasize the presence of man, which would have reduced the sense of naturalness and unconfined primitiveness to a small degree.

Oil and Gas Exploration and Development Activities

Seismic work has occurred over much of the ACP. This work resulted in a short-term impact on the primitive setting of the North Slope and a loss of solitude and naturalness. These impacts would have been confined primarily to the activity site viewshed or noiseshed, or approximately ½ mile in any direction. The potential effects on recreation opportunities and experience were minimized by the fact that very little winter recreation takes place in the area.

A longer-lasting impact occurred from green trails resulting from seismic survey operations. As with green trails created by overland moves, these trails do not necessarily develop over the entire survey route and are visible for about 2 to 5 years. Though relatively short term in nature, the linear nature of these trails would have emphasized the presence of man, which would have reduced the sense of naturalness and unconfined primitiveness to a small degree.

Other sources of potential recreation loss included exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on a report by the NRC (2003), in 2001, approximately 1,200 acres had been impacted by these sites in the past, and 740 acres of disturbed areas were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades.

Disturbances associated with exploration, development, and production activities continue to have a potential affect on the recreational experience. Temporary on-site location of structures (e.g., drilling rigs); noise from generators, vehicles, aircraft, etc.; human presence; and associated activity all would have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences during the winter season. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel footprints had impacted over 9,200 acres, while gravel mines had impacted another 6,360 acres of vegetation. Of this, all but 70 acres of gravel footprint persisted in 2001, but over 4,500 acres of gravel mines were reclaimed. Motorized traffic occurs along about 400 miles of roads (NRC 2003). These impacts to the recreation experience are greatest within a 2-mile radius of the facility, and for permanent, and some temporary, facilities, these effects persist today.

Wilderness Values

Past activities on the North Slope have reduced the naturalness of a portion of the Planning Area and reduced the area affording opportunities for solitude, personal challenge and unusual adventure, and primitive and unconfined recreation. In addition, effects on wildlife have degraded the wilderness experience potential to some degree.

Wild and Scenic River Values

During preparation of the Northwest IAP/EIS, 22 streams and rivers were found eligible for inclusion in the National Wild and Scenic Rivers System (USDOI BLM MMS 2003:V-165). However, no rivers were found suitable for inclusion.

Future Effects and Their Accumulation

Under the final Preferred Alternative, it is expected that long-term impacts over an area of approximately 205,000 acres would occur if oil prices were to average $25 per bbl. Considering past, present, and future development across the North Slope, total cumulative impacts would be additive and could affect an area three to five times greater. Even so, a vast area of the ACP—and certainly more than 80 percent of the North Slope and Planning Area—would remain relatively untouched. However, the types of development anticipated would not be uniformly distributed across the Planning Area or the North Slope, nor would recreational or wilderness values be perceived as uniformly dispersed. Cumulative impacts along popular rivers, such as the Colville River, would be seen as far more important than impacts elsewhere.

Wilderness Values

The cumulative development scenario for all alternatives would reduce the naturalness of a portion of the North Slope where non-oil and gas, and oil and gas development occur or are proposed, including the Planning Area, and Northwest and South National Petroleum Reserve – Alaska, and would reduce the area affording opportunities for solitude, personal challenge and unusual adventure, and primitive and unconfined recreation. In addition, effects on wildlife would degrade the wilderness experience potential to some degree. Nevertheless, most federal lands on the North Slope would remain roadless and would retain the characteristics necessary for future Wilderness designation if political support for such a designation were to coalesce.

Wild and Scenic Rivers

The Colville River and 22 other rivers in the National Petroleum Reserve have been identified as eligible for designation. The Colville River has not been found “suitable” because the BLM controls only the left bank (facing downstream), and neither the local population nor the State of Alaska support designation at this time. The right bank is controlled by the State of Alaska and the Arctic Slope Regional Corporation. These entities could authorize modifications such as airstrips, lodges, cabin sites, or storage facilities in the riparian area that would impact the scenic quality and the free-flowing, clean water nature of the river. Such modifications would make it very difficult to maintain the nondegradation standard of management if the Colville River adjacent to the Planning Area were found suitable for designation as a Wild River Area. Many of the rivers found in the Northwest National Petroleum Reserve – Alaska are in remote areas and would likely not be affected by development, or would be protected by lease stipulations and ROPs.

Effects of Spills

Most spills (65 to 80 percent) would be confined to a pad. Spills not confined to a pad usually are confined to the area immediately around the pad or pipeline. Therefore, impacts on solitude, naturalness, or primitive/unconfined recreation opportunities resulting from spills likely would be confined to the same area as described above.

A large spill that reaches a river, especially the Colville River, and moves rapidly downstream could have disastrous short-term (and possibly long-term) impacts on recreation values.

Global Climate Change

As discussed in earlier sections on Water Resources, Vegetation, Birds, Mammals, and Subsistence, global climate change could impact natural resources on the North Slope and have an effect on the recreation experience and types and timing of recreation activities that could occur.

Contribution of Amendment Alternatives to Cumulative Effects

Under the final Preferred Alternative, it is expected that long-term impacts over an area of approximately 205,000 acres would occur if oil prices were to average $25 per bbl. This would be about 2 times the area that would be affected under the No Action Alternative, but about 25 percent less area than would be affected under Alternative C. Considering past, present, and future development across the North Slope, total cumulative impacts would be additive and could affect an area three to five times greater. Even so, a vast area of the ACP—and certainly more than 80 percent of the Planning Area—would remain relatively untouched. However, the types of development anticipated would not be uniformly distributed across the Planning Area or the North Slope, nor would recreational or wilderness values be perceived as uniformly dispersed. Cumulative impacts along popular rivers, such as the Colville River, would be seen as far more important than impacts elsewhere.

Wilderness Values

The cumulative development scenario would reduce the naturalness of a portion of the Planning Area and would reduce the area affording opportunities for solitude, personal challenge and unusual adventure, and primitive and unconfined recreation under all alternatives. In addition, effects on wildlife would degrade the wilderness experience potential to some degree. Nevertheless, most of the Planning Area would remain roadless and would retain the characteristics necessary for future Wilderness designation if political support for such a designation were to coalesce.

Wild and Scenic Rivers

Although there are no designated Wild and Scenic Rivers in or near the Planning Area at present, the Colville River has been identified as eligible for designation, as discussed above.

Conclusion

Cumulative development activities would degrade the opportunities for primitive recreation in portions of the Planning Area and its surroundings. However, such opportunities would continue to be available over at least 80 percent of the Planning Area. Technically, there would not be cumulative impacts to Wilderness or Wild and Scenic Rivers because there are currently no such areas designated in the Planning Area. However, the area eligible for future designation would be reduced to the degree that a major disturbance occurred. Projected cumulative activities could have local impacts on the free-flowing, unpolluted waters and could affect the outstandingly remarkable values of portions of the eligible Colville River. In such a case, the amount of area potentially suitable for designation would be reduced.

4.7.7.17 Visual Resources

Activities associated with non-oil and gas activities (primarily development associated with villages, military [DEW-Line sites, cabins and campsites, and airfields), as well as inland oil and gas exploration and development and Beaufort Sea oil and gas development have resulted in cumulative effects to visual resources on the North Slope. Minor impacts to visual resources have also resulted from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities.

Past Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Most of the North Slope and Planning Area are still primarily a natural landscape where humans have not substantially changed the scenic quality. However, some areas have been modified by human activities. Buildings are the most likely to be seen and have the most modification from the natural landscape. The main areas where buildings exist near the Planning Area are Nuiqsut, Umiat, Camp Lonely, and Lonely DEW-Line site; other sites on the North Slope include Atqasuk, Anaktuvuk Pass, Barrow, Wainwright, and several other former military sites.

Landscape modifications associated with villages and temporary developments, including single family houses, temporary structures, (e.g., sleds, tents), roads, vehicles (e.g., Rolligons, tractors), commercial development, landfills, airstrips, and aircraft have some minimal short-term impacts on visual resources or scenic quality, by creating a contrast to the line, color, and texture of a primarily horizontal natural landscape. The colors of structures and equipment would contrast with the white color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities would contrast the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities that occurred within the Foreground-Middleground Zone of the viewshed likely attracted the attention of the casual observer.

Other buildings found throughout the North Slope are cabins and camp structures associated with subsistence activities. These structures are usually isolated single-story small plywood cabins that produce some contrast with the surrounding landforms, but on a very local scale, along lakes, rivers, and creeks. One exception, however, is along the Miguakiak River and Teshekpuk Lake where structures are more clustered or present as “strip development.”

Airstrips are located at five places within the Planning Area; airstrips are also located at villages, oil and gas fields, and Deadhorse. While the profile of an airstrip is low, landform changes are introduced by brown colors in predominantly green vegetation and more regular lines than the surrounding irregular vegetation.

Capped wells (called Christmas trees) dot the landscape. However, given the small footprint and most being less than 6 feet tall, these modifications are very hard to see unless you are within a couple hundred feet of them.

Permanent roads are primarily associated with the TAPS, local communities, and the oil fields road network. As of 2001, there were approximately 400 miles of oil field roads, about 75 percent of which were constructed by the early 1980s. These roads can be visible from a mile or more away. Very few trails exist very far from any community. Summer travel is primarily by watercraft along rivers and coastal areas. Some areas around Nuiqsut receive travel by ATV, however, these trails are hard to see from more than about 25 feet away. Ice roads are used during the winter months and leave changes in vegetation colors during the summer, but again, this contrast is very hard to see from more than a few feet away.

While these areas introduce modifications to the landform, they also provide places of use and special interest or key observation areas from which to evaluate the sensitivity levels.

A longer-lasting impact has been the green trails resulting from winter overland moves. Green trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails did not necessarily develop over the entire route of the overland move. Vegetation has been damaged along these trails and the tops of tussocks have been scraped off. Green trails are visible for about 2 to 5 years. However, because they visually modified existing vegetation, rather than adding something foreign into the viewshed, green trails have not produced much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Drill rigs (average height of 208 feet) have introduced strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs also produce a strong visual contrast to the white background of the snow-covered landscape. Winter drilling requires lighting, which creates a visual contrast against the dark night sky.

Oil and Gas Exploration and Development Activities

Past development and production of oil and gas has cumulatively impacted about 17,500 acres from surface disturbance associated with roads, pads, and exploration sites; about 12,000 acres of surface impacts are still visible today (NRC 2003). In addition, about 400 miles of pipelines have been constructed at one time or another. Visual impacts from oil and gas facilities and activities have changed the existing landscape from a very natural viewshed to a more industrialized setting introducing vertical lines, regular patterns, and varied colors. From some viewpoints, it is possible that multiple developments could be seen in the Foreground-Middleground Zone, as well as the Background Zone and Seldom-Seen Zones of the same viewshed. These visual effects persist today, and unless sites are dismantled and rehabilitated, would accumulate with future effects.

Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Cumulatively, the non-oil and gas activities that would occur on the Arctic North Slope would be the same as those described under Alternative B. However, green trails and temporary camps would increase as a result of, or in support of, oil and gas development. For example, field activities associated with archeological site clearances (such as camps, excavations, and aircraft activity) would all likely increase.

Although the amount of supplies and materials transported by winter overland moves would increase with additional activity on the North Slope, these moves would generally follow the same routes. New trails could be developed to reach new staging areas and pump stations; however, once a route was identified, numerous trips over the route could occur without additional impacts.

Oil and Gas Exploration and Development Activities

Cumulatively, seismic-survey work would continue, with the number of operations increasing each winter season. These operations could result in hundreds of miles of intermittent green trails, visible from the air during any one summer season. As production of fields increased, seismic work would tend to decrease and green trails would reduce in number and recover naturally.

Present development and production could impact less than 1 percent of the North Slope, while reasonably foreseeable future development could impact around 1 percent of the North Slope area. However, remediation of old drill sites is ongoing, and many of the impacts have a natural recovery rate of less than 15 to 20 years. The ring effect from old well sites would also naturally recover in less than 15 to 20. Exploration wells would leave behind a marker pipe expected to be no larger than a square foot on the surface and 6 feet tall. This impact would essentially be permanent, although it would be almost unnoticeable from several hundred feet away.

In addition to the impacts that have resulted from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads has caused impacts to visual resources during the summer. This greening of vegetation is caused by the same conditions that create green trails, a greater availability of moisture and nutrients as ice or compacted snow melts. There has also been a “ring effect” around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. The effects of ice roads and pads are short-term, however, and would not accumulate.

Visual impacts from oil and gas activities would continue to become more noticeable as production pads, staging areas, CPFs, roads, gravel mine sites, airstrips, and pipelines change the landscape. In many areas, the increase in development and production would change the existing landscape from a very natural viewshed to a more industrialized setting introducing vertical lines, regular patterns, and varied colors. From some viewpoints, it is possible that multiple developments could be seen in Foreground-Middleground Zone, as well as the Background Zone and Seldom-Seen Zones of the same viewshed.

A road from the Spine Road across the Colville River to Nuiqsut would impact visual resources along its route. The scenic quality along the route would be affected by the removal of native vegetation and the use of gravel, sand, and other road materials where they are not naturally located. The development of material sources (e.g. gravel pits) could have an impact on the visual quality of the adjacent area. Traffic along the route would impact the visual quality from the surrounding area. If the road is opened up to the public, it would allow more of the public to see and enjoy the natural landscapes.

Effects of Abandonment and Rehabilitation. During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of fugitive dust. Once closure activities are completed, the strong contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, would be eliminated.

Effects of Spills. Most spills (65 to 80 percent) would be confined to a pad. Spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline. Thus, there would be no new visual impacts associated with spills.

Global Climate Change

As noted in earlier sections on soil, vegetation, and water, changes in global climate may influence coastal erosion rates, amount of surface water, stability of the soil, and amounts and types of vegetation on the North Slope. All of these effects would have an impact on the visual characteristics of the North Slope and Planning Area.

Contribution of Amendment Alternatives to Cumulative Effects

Under the alternatives, seismic surveys would continue. There would be about 250 miles of 2-D surveys and two to five 3-D surveys for each alternative. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating a color contrast between the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed.

Green trails resulting from seismic survey operations would result in a longer-lasting impact to visual resources and would be similar among alternatives. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like green trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years. Because green trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Approximately 25, 75, 91, or 60 exploration and delineation wells would be drilled under alternatives A through D, respectively, at an oil price of $25/bbl. It is estimated that the long-term disturbance associated with the new wells would be about 10 acres per well. Given the limited number of drilling rigs available, however, no more than three drilling rigs would likely be operating at any one time. Assuming approximately 50 acres of ice pads, airstrips, and roads per drill site, as many as 1,250 (Alternative A) to 4,550 (Alternative C) acres would be in various states of recovery from greening and ring effects under the alternatives.

It is estimated that long-term surface disturbance from pads, roads, airstrips, gravel pits, and CPFs would range from about 300 acres under the No Action Alternative to 1,120, 1,380, and 920 acres for alternatives B through D, respectively. Pad sites generally contain one-story buildings and pipelines. The tan gravel pads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable beyond a few thousand feet. Facilities would introduce strong vertical lines from buildings into the landscape of predominately soft horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would contrast with the greens, browns, and blues of vegetation and water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

It is anticipated that as many as 110 (No Action Alternative) to 330 miles (Alternative C) of pipeline, impacting up to 660 to 1,980 acres (5 to 6 acres per mile), would be constructed. There would be no on-the-ground activities associated with pipelines, except during construction and repair. Pipelines would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. Pipelines would be elevated at least 5 feet above the surrounding tundra, but could be elevated as high as 20 feet above ground level. At these elevations, the pipeline would attract the attention of the casual observer if located within the Foreground-Middleground Zone.

Other facilities associated with development would include gravel mine sites, bridges, roads, airstrips, and communications towers. Disturbance associated with gravel mine sites would generally occur below the ground surface, with only stockpiled materials being visible aboveground. While these sites could be large in size or footprint, very little material would remain as stockpile at any one time. If located within the Foreground-Middleground Zone, only bridges, because of their contrast with smooth water bodies, and communications towers, because of the vertical height above the horizon, would be likely to attract the attention of a casual observer.

Visual Resource Management Classes. Visual Resource Management classes were not established in the 1998 Northeast IAP/EIS. It is BLM policy that interim Visual Resource Management classes are established when a project is proposed for which no VRM objectives have been approved. Using scenic quality, sensitivity, and distance zones as well as other management factors, the Alpine field area would be assigned three VRM classes. The Colville River, from the southern project boundary to Harrison Bay, including the Delta area, would be VRM Class II. Fish Creek, Judy Creek, and the Tingmiaksiqvik River would be VRM Class III. The rest of the project area would be VRM Class IV.

The 1998 Northeast IAP/EIS ROD assigned VRM classes to the Colville River. The Colville River Special Area will be managed for VRM Class I upstream of Umiat and VRM Class II below Umiat, with exceptions allowed for subsistence structures and essential pipeline crossings.

The Northwest IAP/EIS ROD assigned VRM classes as follows: The lands along the Colville River area are designated VRM Class I. Identified estuarine areas and lands along the 21 rivers eligible for designation as Wild and Scenic Rivers are designated VRM Class II. All lands within 3 miles of the banks of all identified water bodies are designated VRM Class III. The remainder of the Northwest National Petroleum Reserve – Alaska is designated VRM Class IV.

Conclusion

There would be a small increase in the short-term impacts to visual resources from non-oil and gas activities. Short-term impacts, such as green trails, and ongoing activities would not accumulate. Impacts from long-term or permanent facilities such as roads, pipelines, and gravel pads and pits would accumulate and would result in the long-term loss of scenic quality.

Long-term impacts from production sites, staging areas, and pumping stations with a possible life span of over 30 years would affect visual resources in the North Slope. It is expected, however, that these impacts would be greatest within the Foreground-Middleground Zone of the viewer. Pipelines could be elevated above ground level and would be visible from ½ mile or more away. Except during construction and repair of pipelines, there would be no associated on-the-ground activity. Therefore, long-term impacts to visual resources from pipelines would be expected to be minimal if located beyond the Foreground-Middleground Zone of the viewer.

4.7.7.18 Economy

Introduction

This section addresses the cumulative effects of past, present, and future activities on the economy of the North Slope. The economy of any area is ultimately global in scale, however, the focus of this assessment is on the entire NSB economy, although some influences on the economy may be more localized and only affect one or two communities within the NSB. Four primary indicators are used to assess cumulative effects on the economy. These four indicators are NSB revenues, jobs, population, and per capita income. Since subsistence is an important part of the local economy, it is also discussed in this section. Section 4.7.7.12 (Subsistence) provides the primary discussion of cumulative effects on subsistence. Key events or factors are described, followed by an analysis of these events, and a discussion of the trends that have affected the economy and are expected to continue into the future.

Past Effects and Their Accumulation

Key Events/Factors

As shown in Figure 4-4, the following subsections describe some of the major economic events or factors that led to the present situation, those situations and trends that are anticipated to continue into the future, and reasonably foreseeable future events that would affect the economy.

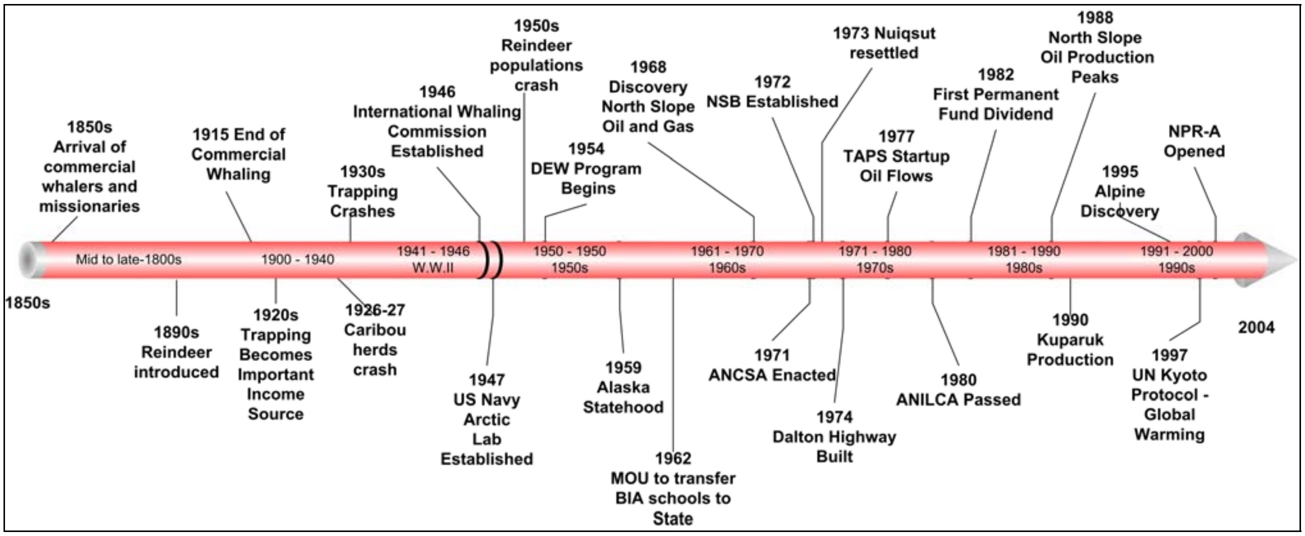

Figure 4-4. Major Events Affecting the North Slope Economy, 1850 –2004.

Any discussion of the economy of the North Slope must recognize that subsistence was, and continues to be, the basis of the economy and culture for the Iñupiat people. The assessment of past events begins with the advent of commercial whaling in the 1850s, which is considered the first major event that affected the North Slope economy, and ends with current (2004) oil and gas lease sales that could affect the future economy of the region.

Commercial whalers entered the Chukchi and Beaufort seas in the 1850s, pursuing whales for oil and baleen. Protestant missionaries soon followed, establishing churches in several historic village sites along the coast. Whaling captains hired North Slope Natives as crew members and eventually these Natives became captains of their own ships. In the 1890s, the Bureau of Education introduced reindeer into the region, providing additional food for the herders and a needed source of cash when sold for their meat to whalers and others. By 1915, the overharvest of bowhead whales and the development of substitutes for baleen and whale oil led to the end of commercial whaling.

By the time commercial whaling ended, the cash economy was well integrated into the North Slope economy and other sources of income were needed to compensate for the loss of whaling income. Trapping became an important source of income for the region until the Great Depression brought a substantial decline in demand for furs. In the mid- to late 1920s, the caribou populations crashed and the bands of Iñupiat living in the Brooks Range dispersed to other areas, not returning to the mountains until the late 1940 and 1950s.

World War II saw the development of airports around the state, and North Slope residents were involved as Army Scouts. Few other events of major significance occurred during this period. After World War II, the International Whaling Commission was established and the U.S. Navy built its Arctic Research Laboratory near Barrow. The Navy also began its early petroleum exploration on the North Slope. Both of these activities provided steady employment in the region. As the Cold War evolved, and the threat of nuclear war emerged, the Department of Defense began to build the DEW-Line radar sites along the Alaska coastline from 1955 to 1957. This construction activity and operations provided some employment for local residents.

Alaska became a state in 1959, and by 1962 an MOU was signed to transfer Bureau of Indian Affairs schools to the state; however, many Bureau of Indian Affairs schools continued to exist in the state until the early 1980s.

As pointed out by the NRC (2003), the discovery of oil in 1968 at Prudhoe Bay "accelerated political processes for resolving complex issues of land tenure and rights…." The Alaska Native Claims Settlement Act (ANCSA) established the ASRC and the village corporations in 1971, and led to the formation of the NSB in 1972, as well as the resettlement of the villages of Nuiqsut in 1973 and Atqasuk in 1974.

The Dalton Highway opened in 1974 and the first oil flowed down the TAPS in 1977, providing a wealth of revenues to the State of Alaska and the NSB, with the first Permanent Fund Dividends paid to residents of the state in 1982. The ANILCA in 1980 established the network of national parks, refuges, wilderness areas, preserves, and other federal land ownership that exists today on the North Slope.

Peak oil production from the Prudhoe Bay field was reached in 1988 and production began to decline. Production from the Kuparuk field started in 1990, after there was sufficient capacity in the TAPS to accept more oil. The petroleum industry had limited exploration success after the early discoveries in the late 1960s and early 1970s, until the discovery of the Alpine field in 1995. Alpine, located near the eastern boundary of the National Petroleum Reserve – Alaska, represented a new geologic concept for oil reservoirs on the North Slope and provided further impetus for opening the Reserve to exploration to private companies.

Revenue

Aside from the petroleum industry, the NSB is the dominant economic organization on the North Slope. The NSB taxes the oil and gas facilities and uses the revenues to provide education and a wide array of other public services within its boundaries. Property taxes on oil and gas infrastructure provide over 95 percent of the total revenues received by the NSB. The value of the infrastructure is based on the estimated value of the profits that can be generated with these facilities. As the amount of oil reserves remaining in the ground declines over time, the value of the facilities also diminishes, followed by subsequent reduction in the property taxes generated. The NSB has used its taxing authority to issue bonds that are used for capital improvement projects and has pledged much of its future revenues to pay for these projects. The NSB must meet its debt service requirements on these bonds even if oil and gas property taxes decline, thus the result can be a substantial decline in operating budgets if tax revenues are diminished.

Prudhoe Bay and Kuparuk were the largest and second-largest fields discovered in North America. Even though theses fields are in decline, they still produce a significant portion of the total oil production on the North Slope. As new fields are brought on line, the profit generating potential of those facilities is recognized with associated changes in the property taxes that can be generated. Figure 4-5 shows the change in oil and gas property taxes received by the NSB from 1975 through 2003. Installation of new facilities and development of new fields can result in periodic upturns in the amount of oil and gas property taxes, but the trend of declining oil and gas property taxes is anticipated to continue in the long term. If a gas pipeline were built, however, it is expected that there would be a substantial shift upwards in NSB oil and gas property taxes; in the absence of a gas pipeline, the current downward trend would likely persist.

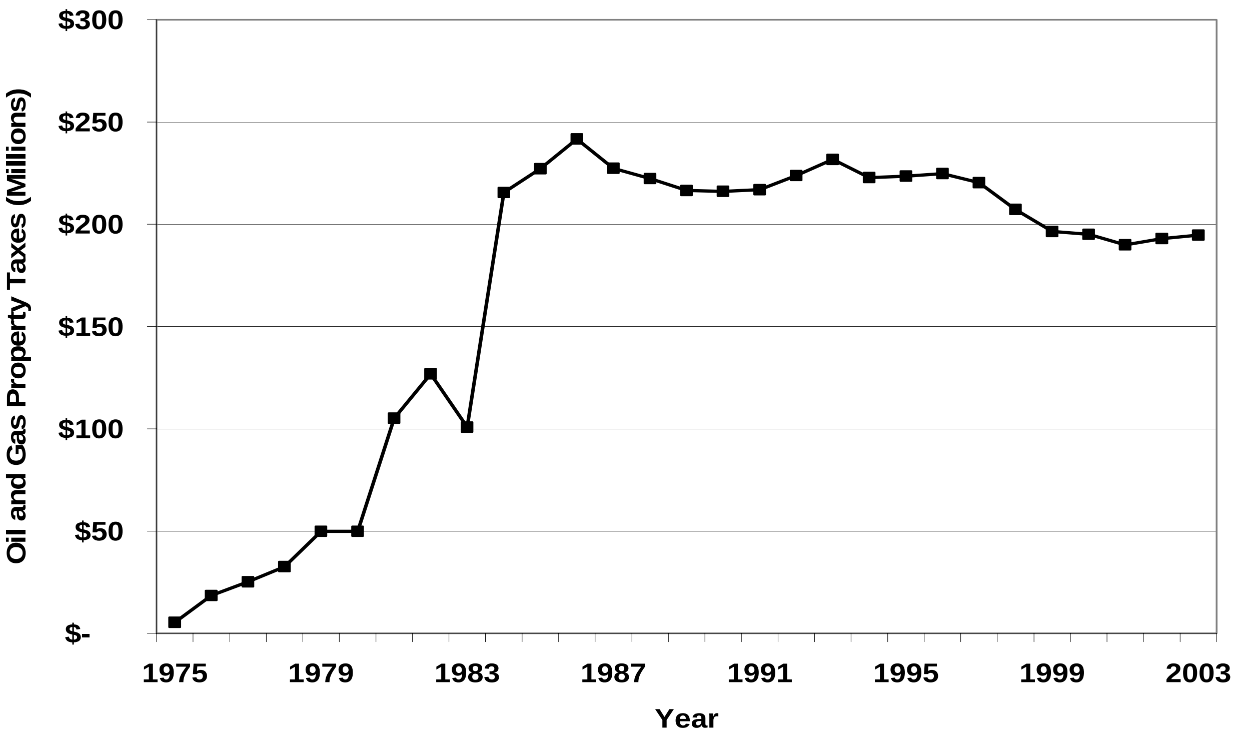

Figure 4-5. North Slope Borough Oil and Gas Property Taxes, 1975 – 2003.

Jobs

As evidenced by Figure 4-6, without the discovery of oil at Prudhoe Bay in 1968, the number of jobs that would be available for North Slope residents would be substantially fewer than presently exist. Although most of the oil and gas-related jobs are held by people that reside outside of the NSB, jobs funded by the NSB's property tax revenues account for the vast majority of the remaining jobs (outside of the oil and gas sector). The number of jobs in the oil and gas-related sector has fluctuated with the development of new fields, and the development and end of construction of new, large fields (e.g., Kuparuk and Alpine) is evident. This volatility in employment is expected to continue, and the success of the petroleum industry in finding new commercial fields will be a large factor in future employment levels.

The decline in NSB associated employment is evident from information provided on the Alaska Department of Labor's web site. In 2003, average annual monthly employment in the construction industry was only 171 jobs, the lowest number of construction jobs since employment records by industrial sector for the NSB became available in 1980. Local government employment also declined to 1,838 jobs, the lowest level since 1992.

Figure 4-6. North Slope Borough Employment, 1965-2003.

Population

The population of the NSB has increased substantially over the past 6 decades, partly in response to increased employment opportunities and as the result of improved living conditions and increased life expectancy rates for Iñupiat people. However, as shown in Figure 4-7, population growth in the NSB has slowed significantly over the past several years and has declined for four straight years since 1999. The reduction in jobs supported by the NSB has likely resulted in the emigration of residents who are seeking employment opportunities, since few NSB residents are employed in the North Slope oil industry, and a reduction in the number of people migrating into the NSB for employment opportunities.

Per Capita Personal Income

As shown in Figure 4-8, real (inflation adjusted) per capita personal income in the NSB has declined from peak years in the 1970s and early 1980s, with over $40,000 in income, to under $30,000 in income in the latter part of the 1990s. In comparison, per capita personal income for the state remained between $25,000 and $30,000 from the 1970s through the early 1980s, and has remained relatively stable from the early 1980s through the end of the last decade. Since 2000, per capita personal incomes in the NSB rose to about $35,000. Incomes across Alaska also rose since about 1997, reaching new historic highs in 2001 and 2002. Much of this recent increase is due to direct Congressional appropriations that have occurred as a result of Senator Stevens's role as Chair of the Senate Appropriations Committee and as a result of the emigration from the NSB (slight increases in total income divided by fewer people result in larger increases in per capita income).

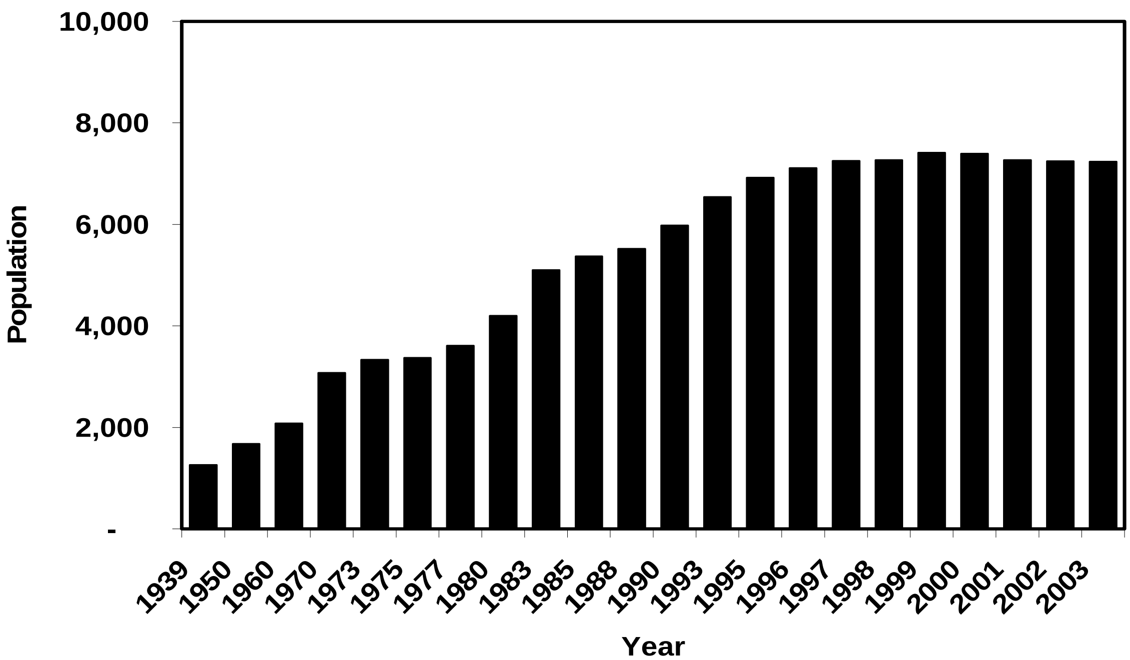

Figure 4-7. North Slope Borough Population, 1939-2003.

Subsistence

Iñupiat tend to begin their time allocations with wage labor decisions and then divide the remaining time between subsistence and leisure. In other words, North Slope residents tend to allocate relatively less time to subsistence as they increase their employment time.

Increased income has led to the adoption of more efficient, reliable, useful, and less-demanding subsistence technology. For example, those with financial resources frequently counterbalance limited leisure time by using motorized equipment (e.g., three-wheelers, snowmachines, and outboard motors for boats) to reduce travel time. The widespread use of these modern modes of transportation also makes it possible for large numbers of people to concentrate in a single settlement and still hunt and fish over a large area. However, the adoption of modern technology raised the cost of participating in subsistence activities in the NSB given the lack of low cost transportation links where few goods and services escape a substantial transportation premium.

Being employed part-time appears to be complementary to subsistence participation. For example, if a person works part of the year, a small decrease in employment time increases the amount of time for subsistence activities and raises subsistence hunting or fishing effort. On the other hand, extended underemployment or unemployment represents a major impact that could sharply reduce wage income. This wage reduction, in turn, diminishes the individual's ability to participate in subsistence because they may not be able to acquire the necessary capital inputs (for example, snowmachine, boat motor, ammunition, and gasoline). In other words, extended underemployment or complete job loss may produce income loss-related effects that overwhelm those associated with more leisure time. The recent reduction in construction employment, which is the primary occupation for many male Iñupiat in the villages, could make it more difficult for these individuals to participate in subsistence activities and provide, by subsistence activities, for their families and community.

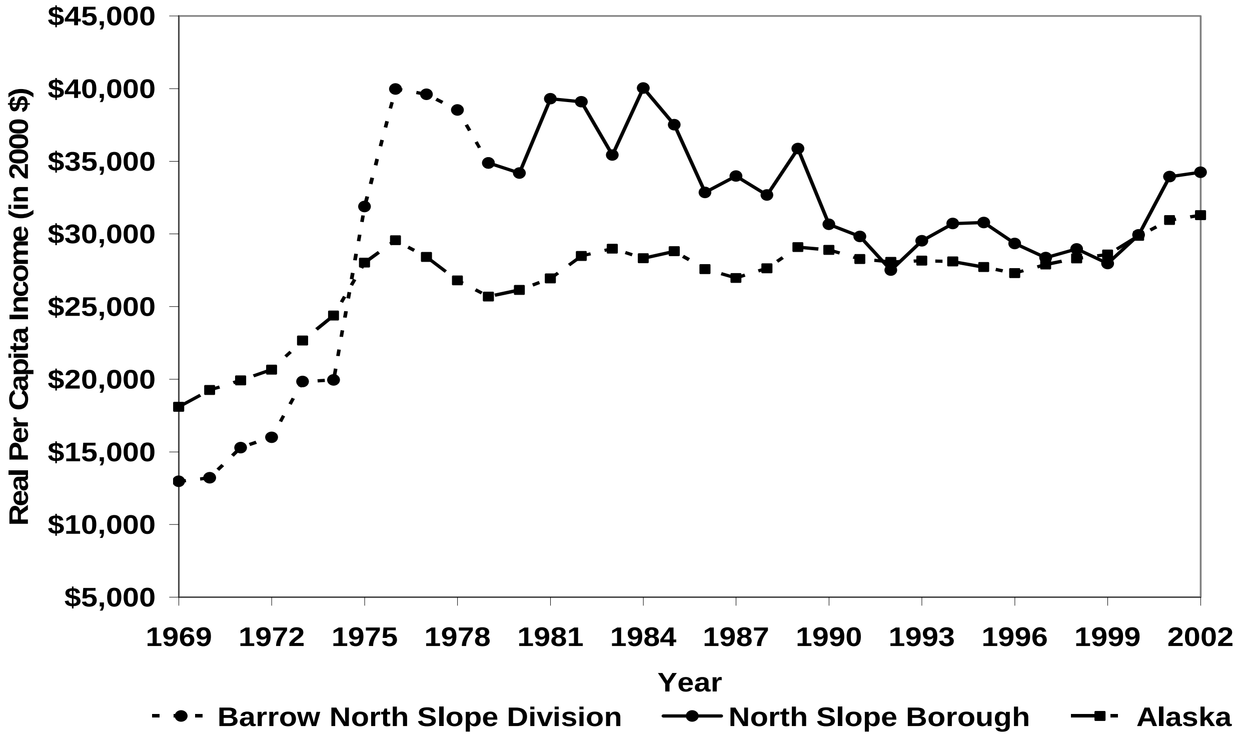

Figure 4-8. Real Per Capita Income, North Slope and State of Alaska, 1969 – 2002 (Year 2000 $).

At the other extreme, full-time employment also reduces subsistence activity even with the liberal subsistence activity leave policies of the NSB and other companies. If oil and gas development and production in the Planning Area would provides employment opportunities for Nuiqsut residents or other NSB residents, the additional income could help pursue subsistence activities, but the opportunities are not expected to be sufficient to offset the declines from other fields.

Summary of Past Effects and Their Accumulation

Subsistence was, and continues to be, the basis of the economy and culture for the Iñupiat people. The assessment of past events begins with the advent of commercial whaling in the 1850s, which is considered the first major event that affected the North Slope economy, and ends with current (2004) oil and gas lease sales that could affect the future economy of the region. Aside from the petroleum industry, the NSB is the dominant economic organization on the North Slope. The NSB taxes the oil and gas facilities and uses the revenues to provide education and a wide array of other public services within its boundaries. Property taxes on oil and gas infrastructure provide over 95 percent of the total revenues received by the NSB. Population growth in the NSB grew sharply until the mid-1980s, and then has slowed significantly over the past several years and has declined for four straight years since 1999. Real (inflation adjusted) per capita personal income in the NSB has declined from peak years in the 1970s and early 1980s, with over $40,000 in income, to under $30,000 in income in the latter part of the 1990s. Increased income has led to the adoption of more efficient, reliable, useful, and less-demanding subsistence technology. However, full-time employment reduces the amount of time available for subsistence activities.

Future Effects and Their Accumulation

Key Events/Factors

The BLM, MMS, and the State of Alaska continue to hold lease sales for onshore and offshore oil and gas exploration in Alaska. However, the response of the oil industry to these recent lease sales demonstrates the industry's recognition of the high cost and high risk of exploration in areas located far from current infrastructure. While some exploration activities are occurring far from current production areas, most exploration is located near existing infrastructure in order to reduce costs or exploration and achieve a higher probability of finding economically viable reserves.

The Alpine satellite fields are examples of this type of exploration activity. Colville Delta-3 (Fjord) was discovered approximately 6 miles north of Alpine, and CD-4 (Nanuq) was discovered about 4 miles south. Colville Delta-5 (Alpine West) is about 3 miles from CD-2, CD-6 (Lookout) is about 10 miles from CD-5, and CD- 7 (Spark) and CD-6 are separated by about 6 miles.

Fjord and Nunaq are located on lands owned by the State of Alaska and the Kuukpik Corporation, the Alaska Native village corporation for Nuiqsut. The subsurface rights to the oil and gas are held by the State of Alaska and ASRC. A similar situation exists for the Alpine field. Alpine West is proposed to be located within the National Petroleum Reserve – Alaska, on Kuukpik land and an ASRC oil and gas lease. The royalties to ASRC from production of these fields would generate substantial revenues for the corporation and its shareholders. Seventy percent of these petroleum royalties would be shared with the other Alaska Native regional corporations in accordance with Section 7(i) of ANCSA.

Reasonably foreseeable events that would affect the economy of the NSB include actions associated with future oil and gas lease sales and other activities in the northeast and northwest portions of the National Petroleum Reserve – Alaska, natural gas, hard rock minerals and coal exploration and production in the southern portion of the National Petroleum Reserve – Alaska, and subsequent leases and exploration and production from state and ASRC-owned lands in proximity to the National Petroleum Reserve – Alaska. In the absence of a natural gas pipeline, it is anticipated that revenues to the NSB would continue to decline with subsequent adverse effects on the ability of the NSB to provide the number of jobs that it has in the past.

Revenue

The current downward trend in declining oil and gas property taxes, accounting for over 95 percent of the revenues received by the NSB, is expected to continue is the absence of a gas pipeline. Potential oil production from recent and future lease sales in the National Petroleum Reserve – Alaska could help to slow this decline, but is not expected to reverse the trend.

Jobs

As oil fields mature they typically require more employees per unit of production, so even though profits and property taxes may decline, employment in the oil and gas sector may remain constant or even increase slightly. However, in the government sector and other sectors funded primarily by the NSB's property tax receipts, employment is expected to decline as property taxes decline. Employment in the oil and gas sector could remain within the range of employment levels experienced between 1980 and 2003, while the number of jobs supported by the NSB's property tax revenues is expected to decline in concurrence with the reduction in tax receipts cited above. Current and future lease sales on the North Slope could help to mitigate some of these employment losses, but are not expected to offset them.

Population

The NSB population is not expected to increase if additional jobs cannot be created, or if NSB residents cannot acquire the training and experience necessary to obtain jobs in the oil industry. While short-term population declines may occur, it is anticipated that over time the NSB and other organizations would develop training programs and undertake other activities to provide NSB residents with the necessary skills and experience to work in the local oil industry.

Per Capita Income

The recent increase in per capita income is expected to continue through 2005, and then level off or decline slightly as Senator Stevens's new committee position could have less influence on the congressional budget. Future changes in employment opportunities and migration of NSB residents would also affect this indicator. The longer-term trend in decreasing per capita income may continue unless NSB residents seek opportunities in the North Slope petroleum industry. The availability of employment opportunities in the Planning Area, with development and production of known and potential oil fields, could increase employment opportunities for Nuiqsut residents who live in close proximity to these fields. While wages associated with this employment could raise the per capita income for Nuiqsut residents, it would likely represent a very small increment for the NSB.

Subsistence

Participation in the cash economy has changed expectations of NSB residents about the quality of life in their communities compared to several decades ago. However, as construction jobs in the villages diminish with the reduction in the NSB's capital improvement program, it could become more difficult for some residents to continue their same level of participation in subsistence activities and maintain their quality of life. When faced with a situation of fewer jobs and less income, village residents have a choice of reducing their quality of life by spending more of their available income on food and less on other items, focusing on subsistence activities that require less capital, but which may not provide the variety and quantity needed, seeking work outside of the community, and moving away from the community to seek employment opportunities elsewhere. None of these options may be appealing to village residents whose circle of family and friends is centered in the community. In the absence of subsistence activities, residents would have few alternatives, but to leave or seek employment outside of the community. Employment opportunities and taxes and royalties paid by potential development in the Planning Area would help mitigate the decline in NSB revenues, but are not anticipated to be enough to offset the decline from other fields.

Global Climate Change

The Kyoto Protocol on global climate change was signed in 1997. Under the protocol, developed nations agreed to limit their emissions of greenhouse gases. The United States has yet to ratify the treaty and as a result, there is a great deal of uncertainty regarding the implementation of the protocol and its potential effects on energy production and consumption in the U.S.

Contribution of Amendment Alternatives to Cumulative Effects

The combined average annual property taxes to the NSB and State of Alaska from future oil development in the Planning Area could range between $5.4 million (No Action Alternative) and $24 million (Alternative C) depending on the price of oil and the resulting infrastructure development. The estimated annual royalty and severance payments would range from $13 million to $79 million for the federal government, $6.5 million and $39.4 million for the NSB, and $6.5 million and $39.4 million for the state government. Moreover, annual severance taxes estimated to be generated would range from $22 million to $131 million.

It is anticipated that employment would increase in the range of 78 to 407 jobs during the peak of development and 9 to 52 jobs during production.. The annual employment of Alaska residents (excluding residents of the NSB) would increase in the range of 1,109 to 5,798 jobs in the peak of development, and 396 to 2,386 jobs during production.

The proximity of Nuiqsut to the Planning Area enhances the community's opportunities to benefit from development and production activities associated with the final Preferred Alternative. These opportunities could extend to community businesses that might provide goods and services, as well as residents who might obtain work as a result of the development and production activities.

Conclusion

Subsistence activities (non-cash economy) and the oil and gas industry (cash economy) are the primary factors that affect the economic livelihood of the North Slope residents. The NSB has successfully leveraged tax revenues generated from oil and gas properties to improve the quality of life of its residents by providing basic services such as water, sewer, electricity, fire protection, police protection, education, health services, and by building infrastructure to support these services through capital improvement projects. Construction jobs associated with the NSB's capital improvement projects have provided residents with employment opportunities that pay relatively well and allow for flexibility to accommodate subsistence activities.

As expected, property tax revenues have decreased through the years, as oil and gas production decline and facilities continue to depreciate. Correspondingly, historical employment data indicate a declining trend in the number of jobs in the North Slope. The declining trend in revenues, jobs, and per capita incomes are expected to continue into the future (absent a major economic event such as the natural gas pipeline project that would create a natural gas industry). It seems reasonable to envision a future trend with more North Slope residents participating in oil and gas activities as Borough-related employment opportunities become very limited. This could mean a tradeoff in subsistence activities as jobs in the oil and gas industry would not be able to provide the same level of flexibility as the Borough and construction jobs.

Events in the reasonably foreseeable future, such as exploration and development in other areas of the National Petroleum Reserve – Alaska, could mitigate these declining trends, but are not expected to offset these declines. The development associated with the Northeast National Petroleum Reserve – Alaska could also have implications at the national level. The Department of Energy estimated that the contribution of North Slope crude to domestically produced oil supplies would decline from 18 percent in 2004 to 14 percent in 2020; again, this decline could be mitigated, but not offset, by opening up the Northeast National Petroleum Reserve – Alaska to oil and gas exploration. Any increase in domestic oil production is expected to reduce U.S. dependency on foreign oil supplies, and, in turn, improve national energy security and the overall balance of trade.

4.7.8 Incremental Contribution of Alternatives to Cumulative Effects

For this cumulative effects analysis, the incremental contribution of an alternative to cumulative impacts is assumed to be proportional to the projected level of activities for that alternative. In general, the likelihood of interaction between oil and gas activities and surface resources is related to the number of activities that occur. However, if an action occurred in an area with a high resource value, for example, in an area with a high density of nesting eiders, effects to the resource could be much greater than predicted based on the number of activities or their projected area of impact.

The incremental contribution to cumulative effects would be greatest under Alternative C because the highest levels of activities and the greatest volume of production are projected under that alternative. Alternative C would also make the most area available for leasing. With consideration of the variables and factors above, Alternative C is projected to contribute approximately 10 to 15 percent to the overall cumulative impacts to the resources addressed in this amendment.

Under the final Preferred Alternative, about 33 percent fewer wells are projected to be drilled, 33 percent fewer fields are projected to be developed, and about 34 percent less oil is projected to be produced than under Alternative C. It is assumed, therefore, that the incremental contribution to cumulative effects would be about 33 percent less under the final Preferred Alternative than under Alternative C.

Under Alternative B, about 16 percent fewer wells are projected to be drilled, 17 percent fewer fields are projected to be developed, and about 18 percent less oil is projected to be produced than under Alternative C, and about 25 percent more wells are projected to be drilled, 25 percent more fields are projected to be developed, and about 25 percent more oil is projected to be produced than under the final Preferred Alternative. It is assumed, therefore, that the incremental contribution to cumulative effects would be about 17 percent less under Alternative B than under Alternative C, and about 25 percent more than under the final Preferred Alternative.

Under the No Action Alternative, about 78 percent fewer wells are projected to be drilled than under Alternative C, 83 percent fewer fields are projected to be developed, and 61 percent less oil is projected to be produced. It is assumed, therefore, that the incremental contribution to cumulative effects would be about 61 to 83 percent less under the No Action Alternative than under Alternative C. Under the No Action Alternative, about 67 percent fewer wells are projected to be drilled than under the final Preferred Alternative, 75 percent fewer fields are projected to be developed, and 41 percent less oil is projected to be produced. It is assumed, therefore, that the incremental contribution to cumulative effects would be about 60 to 80 percent less under the No Action Alternative than under the final Preferred Alternative. Under the No Action Alternative, about 74 percent fewer wells are projected to be drilled than under Alternative B, 80 percent fewer fields are projected to be developed, and 53 percent less oil is projected to be produced. It is assumed, therefore, that the incremental contribution to cumulative effects would be about 53 to 70 percent less under the No Action Alternative than under Alternative B.

4.7.9 Cumulative Effects Outside of the Planning Area from the Transport of Northeast National Petroleum Reserve – Alaska Produced Oil

The BLM analyzed the impacts of operating TAPS over the next 30 years in the *Final EIS Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way* (USDOI BLM 2002a). The TAPS EIS assessed most impacts of the pipeline as small, localized, and short term. Vegetation and soils would be disturbed in very small areas along the 800-mile-long pipeline, and the risk of affecting paleontological or cultural resources was assessed as very remote. Impacts on subsistence and human health would be small, although the EIS estimated that over the course of the next 30 years there could be six fatalities and less than a hundred time-loss injuries to workers. Impacts on air, water, fish, birds, and mammals would all be small, except in the event of an unlikely large spill. Oil spills could create temporary public health risks to people in the immediate vicinity. Large oil spills could have substantial impacts on groundwater, surface water, and the marine environment. A large spill into certain water bodies could, depending on the circumstances, cause severe and possibly long-term impacts to fish. A very large spill, or one that contaminated a crucial habitat, would also be the only means by which impacts to bird or mammal populations would likely occur.

The cumulative effects of transporting Alaska North Slope oil (which would include oil produced from the Northeast National Petroleum Reserve – Alaska) by tanker from the Port of Valdez to the U.S. West Coast and Asian markets were evaluated in the *Liberty Development and Production Plan Final EIS*, which is incorporated by reference (USDOI MMS 2002a). The analysis estimated the number of cumulative tanker spills to be nine, including six spills with an average size of 3,000 bbl (four of which would occur in port and two of which would occur at sea), two spills with an average size of 13,000 bbl (both of which would occur at sea), and one spill of 200,000 bbl (at sea in the Gulf of Alaska). It was predicted that the six spills at sea and the one larger spill would not occur within the same location or contact the same resources before recovery of the affected resource. In-port spills, for which contingency measures would be in place, would be cleaned up relatively quickly. Spills originating 80 to 100 miles offshore would have a 5 to 10 percent chance of contacting the shore within 30 days. Weathering and dispersion of the oil during this time would reduce effects. When past effects have been studied, spills of 13,000 bbl or less at sea have not been found to cause serious effects to birds, fish, or marine mammal populations. A spill along the route to Asian markets would be expected to move parallel to the Alaska Peninsula and the Aleutian Island chain. Production from the Planning Area would account for approximately 13 percent of the total reasonably foreseeable future volume of oil moved to port via TAPS.

The TAPS analysis predicted few, if any, effects to threatened and endangered species from a tanker spill. For example, bowhead whales and their habitat are far removed from the tanker routes; spectacled eiders do not occur in the area that could be contacted by oil; and an oil spill would be unlikely to reach either the densely populated Steller's eider wintering area or northern sea otters and their habitat along the Alaska Peninsula or Aleutian Island chain. Potential effects to salmonids and other fish species, including the tidewater goby, Sacramento splittail, Pacific hake, white abalone and black abalone, appear limited. An oil spill in Prince William Sound or the Gulf of Alaska could have cumulative effects on sea otters in those areas and local effects on harbor seals.

Only a large, 200,000-bbl spill could cause serious effects to marine and coastal birds in the Gulf of Alaska. An oil spill in Prince William Sound could have local, cumulative effects on river otters and brown and black bears in the area. A spill could affect lower-trophic level organisms, such as plankton, algae, and seaweed that experienced contact. A 200,000-bbl spill could affect commercial fishing and result in an economic loss ranging from 37 to 64 percent per year for 2 years in the area affected by the spill. Smaller oil spills would not be expected to have measurable effects on fish species (including anadromous species) or result in measurable effects on sport fishing. If oil contact were to occur, wetlands in Prince William Sound and along west coast routes to Seattle, San Francisco Bay, and Los Angeles could experience local, cumulative effects from contact and damage caused by clean-up operations. Subsistence harvest for residents of Cordova and Yakutat, Alaska, could be reduced or altered, especially if the 200,000-bbl spill contacted and caused serious, long-term effects to sea otters, coastal birds, and harbor seals. Similarly, economic losses to the commercial fishery described above would also represent a serious loss to the subsistence fishery. A spill of that magnitude would also cause serious institutional stress and disruption to associated sociocultural systems in Cordova that could last for 4 years, with lesser effects on Yakutat. These effects would be similar to the effects experienced by these communities as a result of the *Exxon Valdez* oil spill. Archaeological resources in an area contacted by oil spills could be affected by clean-up activities, oil contamination, and vandalism, although protocols are in place to identify sites and minimize impacts from cleanup. A 200,000-bbl spill could create 10,000 cleanup-related jobs for 6 months in the first year, declining to zero by the fourth year following the spill, along with local price inflation of up to 25 percent during the first 6 months following the spill.

Effects to water-quality would vary with the location and size of the spill. Generally, the concentration of hydrocarbons in the water column would be high during the first several days following the spill, decreasing over time to background levels. While overall air quality effects from tanker transportation would be considered low, an oil spill could result in localized increases in ambient VOC concentrations caused by spill evaporation.

The potential effects of a 200,000-bbl oil tanker spill along the TAPS tanker route were analyzed in the *Gulf of Alaska/Yakutat Planning Area Oil and Gas Lease Sale 158 EIS* (USDOI MMS 1995b). The 1998 Northeast IAP/EIS used that information to analyze tanker spills occurring from production in the Planning Area (USDOI BLM and MMS 1998:Appendix B). That analysis affirms the conclusions (summarized above) of the Liberty EIS and is incorporated here by reference.

4.8 Unavoidable Adverse Effects

This section summarizes the unavoidable adverse effects that would occur under the alternatives considered in this amendment. Under the alternatives, the land allocations for oil and gas leasing range from making all BLM-administered lands in the Planning Area available for leasing (Alternative C) to making approximately 87 percent of lands available for leasing (the No Action Alternative). Unavoidable adverse effects would be expected to occur during oil and gas exploration, development, and production operations. Many of the adverse effects identified in this section would occur only if a large oil spill were to occur; however, such an event is unlikely to happen.

4.8.1 Air Quality

An increase in emissions of air pollutants would occur as a result of all alternatives. In all the alternatives and the cumulative case, the projected emissions would be less than emissions that have occurred in the past when production rates were much higher. For all alternatives, the limits to air quality standards would not be exceeded.

4.8.2 Paleontological Resources

The loss of paleontological resources has the potential to be adverse, especially if it results in the loss of scientifically important fossils. However, if surveys and inventories in areas of proposed oil and gas exploration and development activities were conducted before work began and avoidance of paleontological resource sites was possible, the incidence of impact would be greatly reduced and any impacts would be minimal. Lease stipulations and ROPs that restrict or prohibit oil and gas drilling and development in streams and rivers would reduce the likelihood of impacts to paleontological resources in the Planning Area. Additionally, strict enforcement of lease stipulations requiring non-collection of fossils also would avoid adverse impacts to paleontological resources. Included in these lease stipulations would be a mandatory training program for the workers on the importance of preserving and not collecting paleontological resources.

4.8.3 Soil Resources

While impacts to soils from exploratory drilling would occur over a small area, relative to the overall Planning Area and ACP, these impacts would be unavoidable and permanent. Development activities, such as the construction of permanent gravel pads, could cause damage or loss of soil over the area affected. Construction of any oil and gas pipelines or the use of a gravel mine site would also permanently disturb or destroy soil in the immediate vicinity of the project. If a crude or refined oil spill occurred, the resultant impact to soils could extend beyond the immediate work area. Lease stipulations and ROPs, however, would reduce the majority of effects. Once abandoned, disturbed areas would likely revegetate, and over time, lead to the development of new soil on the site as dead vegetation and mineral matter combine to make new soil.

4.8.4 Water Resources

Activities from road and pad construction could produce unavoidable adverse effects to water resources. For example, culvert and bridge work in streams and lakes could disturb stream banks or shorelines; blockages of natural channels and floodways could disrupt drainage patterns; and removal of gravel and water from riverine pools and lakes could increase erosion and sedimentation. Because roads would pose the single most critical impact to water resources because of the diversions, impoundments, and increased sediments runoff they would create, limiting the length of the roads would be the most effective way of reducing impacts to water resources.

Construction would result in short-term subsidence of the ice-rich permafrost along stream banks and lakeshores, especially in areas where waves would accelerate the removal of the protective soil and vegetative cover. Fine-grained sediments melting out of the ice-rich permafrost would increase sediment erosion and the associated changes to stream channel morphology.

Unavoidable adverse effects on water quality could occur from spills, and from construction of ice roads and gravel pads, airstrips, and roads. Lease stipulations and ROPs have been developed to minimize the risk of spills, and to provide for spill cleanup. Construction disturbances would be permitted (approved) after subsequent environmental reviews; therefore, impacts could be minimized or avoided. As noted in NRC (2003), the oil industry and regulatory agencies have made substantial progress in slowing the accumulation of effects of gravel fill by reducing the size of the footprint required for facilities and substituting ice for gravel in some roads and pads. Several lease stipulations and ROPs include requirements and standards to minimize the amount of area of surface disturbance.

Unavoidable adverse effects on estuarine water quality would occur from offshore ice-road and ice-pad construction and petroleum-related spills. The construction would have very localized, short-term effects on estuarine water quality.

The construction of coastal staging facilities would have unavoidable adverse effects on estuarine water quality. Construction disturbances would be permitted (approved) after subsequent environmental reviews; therefore impacts could be minimized or avoided. Construction would have very localized, short-term effects on estuarine water quality, while spills could have a longer-term impact on marine waters.

4.8.5 Vegetation

All of the direct impacts to vegetation described for all alternatives would be unavoidable. Seismic activities, overland moves, and exploratory drilling would occur during the winter when the ground is frozen and snow-covered. Such activities could cause impacts that linger into the following summer, or longer, in the form of vegetation that appears greener than surrounding areas and shallow water tracks and ponding. Impacts caused by oil/gas field development, such as burial of vegetation under gravel fill and contamination by oil spills, would be unavoidable, direct adverse effects. Placement of gravel drilling pads, roads, airstrips, staging areas, and docks, as well as construction of oil and gas pipelines and the use of gravel mine sites, would permanently disturb or destroy soil and vegetation. Additionally, vegetation and soils may be disturbed by the formation of impoundments where gravel structures alter drainage patterns. Changes in plant community composition, such as those caused by snowdrift and dust accumulation, would account for about 65 percent of the area impacted by oil/gas field development. These types of impacts would have an adverse effect on the original plant community and its associated fauna, but a beneficial effect on the plant communities that colonize those areas.

4.8.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation, soils, and water resources and quality. Please refer to the discussions in this section for each of these resources for information on unavoidable adverse effects on wetlands and floodplains.

4.8.7 Fish

4.8.7.1 Freshwater and Anadromous/Amphidromous Fish

Unavoidable adverse effects to freshwater and anadromous/amphidromous fish would include short-term avoidance behavior and stress related to seismic vibration activity; loss of habitat and reduced productivity created by gravel excavation in spawning, rearing, and overwintering areas; degradation and loss of habitat and mortality of fish eggs and larvae from erosion and sedimentation in streams and lakes; and lethal and/or sublethal effects to fish from oil spills. Oil-spill cleanup activities could compound unavoidable adverse impacts to fish habitat; however, the effects would be unlikely to measurably impact fish populations in the region.

4.8.7.2 Marine Fish

Unavoidable adverse effects to marine fish would occur as a result of seismic surveys, construction in or near marine waters, marine vessel traffic, and oil and fuel spills. Seismic surveys in overwintering areas could have lethal effects on some juvenile fish overwintering there. The construction of a coastal docking facility to offload supply barges adjacent to the Planning Area would affect the movement of some coastal marine and migratory marine fish. The severity of the effects of a docking facility would depend on its location, size, and design characteristics, and whether the facility required an offshore access causeway. Marine vessel traffic used to support onshore industrial activities could temporarily disturb fish. It is estimated that a very large spill (120,000 bbl) would affect 5 to 20 percent of the marine fish population in the immediate area, and would require approximately 3 to 10 years for recovery.

4.8.8 Birds

Some disturbance of birds in the Planning Area by routine activities and oil and gas development would be considered unavoidable. Disturbance related to aircraft traffic (such as aerial wildlife surveys and aircraft support of camps or oil and gas facilities), would be likely to have the greatest impact on birds. Fixed-wing aircraft and helicopters could fly over nesting areas at various altitudes, causing temporary disturbance effects such as displacement of incubating females from nests or broods, potentially allowing predators greater access to eggs or young. Some aircraft disturbance to molting and migrating loons and waterfowl in marine habitats would be unavoidable. Aircraft flights over the Colville River Delta during the fall could impact thousands of shorebirds staging in this area prior to migration. This may be especially problematic for dunlins, the most common staging bird in the area, as they are also undergoing an energetically expensive, premigratory molt at this time. Given that there are a limited number of staging areas along the North Slope, birds may have few options for moving to new areas that provide comparable resources (Andres and Gill 2000; Flint et al. 2003). The presence of roads and pads and activities associated with oil and gas development could also cause unavoidable disturbances that affect tundra-nesting birds. The primary sources of disturbance related to roads and facilities would result from vehicular traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. Impacts would be most important if disturbances were to occur in areas of high bird use such as the goose molting area north of Teshekpuk Lake.

It is likely that habitat would not be a limiting factor for most species nesting in the Planning Area and that many birds displaced by disturbances related to oil and gas development would move to adjacent habitats. In addition, vessel traffic along river systems or in marine habitats could cause temporary displacement of some birds from preferred habitats. Lease stipulations and ROPs would be effective in mitigating many of the effects of disturbance to tundra-nesting birds, but some impacts may be unavoidable. There would also be a permanent loss of bird habitat associated with the construction of gravel roads, pads, airstrips, staging areas, pipelines, and gravel excavation sites. The extent of disturbance or habitat loss on tundra-nesting birds would be related to the location and timing of the disturbance or habitat loss and the species and number of individuals in the immediate area. While it is likely that many birds would move to adjacent habitats, some impacts related to habitat loss could be unavoidable.

4.8.9 Mammals

4.8.9.1 Terrestrial Mammals

Some disturbance and disruption of caribou and some habitat alterations from oil development under all alternatives are unavoidable. Displacement or reduced habitat use by the TLH, WAH, and CAH caribou are likely to be local (within 2 to 2½ miles of oil field roads and pipeline corridors) and long term (greater than 1 generation), and could persist over the life of the oil fields. Some noise and disturbance of other terrestrial mammals would be unavoidable, but would be short term and localized and would not substantially affect mammal populations.

4.8.9.2 Marine Mammals

Provisions under the Marine Mammal Protection Act require lessees to obtain Letters of Authorization that direct them to avoid disturbance to polar bear dens and require the use of non-lethal means to avoid human-bear interactions. Seismic surveying, air, vessel, and ice road traffic, and construction activities would unavoidably disturb small numbers of seals and perhaps a few polar bears, but this effect would be very brief and would not affect seal and bear population abundance or overall distribution in the Planning Area. Increased barge traffic associated with development could also displace migrating whales depending upon the timing of vessel traffic. However, such impacts could be mitigated by limiting vessel traffic during migration periods. The construction of a coastal docking facility to offload supply barges adjacent to the Planning Area could affect seal habitat. The severity of the effects of such a docking facility would depend on its location, size, design characteristics, and whether the facility required an offshore access causeway. Marine vessel traffic used to support onshore industrial activities could temporarily disturb marine mammals.

4.8.10 Threatened and Endangered Species

Disturbance from noise produced by marine vessel traffic supporting oil and gas activities in the Planning Area could be unavoidable, should bowhead whales be migrating past the northern Planning Area boundary. Increased barge traffic associated with development could also displace migrating whales, depending upon the timing of vessel traffic. However, such impacts could be mitigated by limiting vessel traffic during migration periods. Because vessel noise alone is likely to result in only minor changes in whale behavior (Richardson 1999), disturbance from such vessel activity would probably not preclude whale migration or disrupt feeding activities on a long-term basis.

Some disturbance to nesting, brood-rearing, staging, or migrating spectacled and Steller's eiders by routine activities associated with oil and gas exploration and development is considered unavoidable. The types of disturbances that could affect threatened eiders are the same as those discussed above for birds and include vehicular, vessel, and aircraft traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. The impacts to threatened eiders from these disturbances would also be similar to those described above for birds. Because of their threatened status, it would be likely that research activities would be conducted prior to and during development of oil and gas production facilities. These research activities could involve helicopter and fixed-wing aircraft, as well as ground-based activities that could cause disturbances affecting eider nesting and brood-rearing activities. Impacts to eiders would be even greater if disturbances occurred in areas of high eider use such as the tundra ponds north of Teshekpuk Lake. Eiders could habituate to some disturbances or could move to alternate habitats for foraging, nesting, and brood-rearing. There would also be a permanent loss of eider habitat associated with the construction of gravel roads, pads, airstrips, staging areas, pipelines, and gravel excavation sites. Depending upon where development occurred within the Planning Area, such loss could affect habitat preferentially used by threatened eiders.

Lease stipulations and ROPs would effectively mitigate many of the effects of disturbance to spectacled and Steller's eiders, but some impacts could be unavoidable. The BLM expects most disturbances of endangered and threatened species associated with routine activities to be minimized or avoided through compliance with mitigation measures developed through the ESA Section 7 consultation process.

4.8.11 Cultural Resources

Cultural resources are nonrenewable, so any effects would have some importance. Because the exact locations of all potential cultural resources sites are unknown, their disturbance cannot be entirely avoided. There are cultural resources within the Planning Area that may relate to the entire span of human occupation of the region, including locales relating to the first humans to enter the Western Hemisphere. Historic and prehistoric sites may be located anywhere within the Planning Area and represent varied ages, cultures, and functions. Because soil forms slowly in the Arctic, sites that are thousands of years old may be near the surface. If surveys and inventories for cultural resources in areas proposed for oil and gas exploration and development were conducted before the work began, then the effects to cultural resources in these areas would be reduced or avoided. Timely intervention following the discovery of cultural resources would effectively mitigate many effects, either through site avoidance or data recovery. Salvage archaeology to recover remaining site data from a disturbed site would result in the total destruction of the site, although the recovered data would effectively mitigate for this destruction.

4.8.12 Subsistence

Bowhead whales, caribou, fish, seals, birds, wolves, and wolverines are important subsistence resources for NSB residents. Noise and disturbance from seismic surveys, exploration, development, and production could affect the harvest of subsistence resources in the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut. Additionally, disturbance could cause potential short-term impacts to long-tailed ducks and some eider populations. No harvest areas would become unavailable for use, but many subsistence users would avoid areas of oil development because of regulatory exclusion (real or perceived), and potential for contamination of species.

While noise, traffic disturbance, and oil spills would produce chronic, short-term impacts on subsistence species, none of these impacts would lead to the elimination of any subsistence resource. Disturbance to, and displacement of, caribou could lead to an unavoidable reduction in the total annual caribou harvest by making the harvest more difficult, costly, and time consuming for subsistence hunters. Wolf and wolverine harvests would be reduced in areas of human activity, while bear and fox could habituate to oil and gas activities within the Planning Area.

Effects on the harvest of other species from noise and traffic disturbance, and construction activities should be avoidable, if mitigated. If oil and gas infrastructure were located in subsistence hunting areas, some (real or perceived) restrictions on access by subsistence hunters would be unavoidable.

4.8.13 Sociocultural Systems

The inability to harvest sufficient quantities of bowhead whales as a result of disturbance could cause unavoidable effects on Iñupiat traditional harvesting and sharing practices. These effects would increase if the harvest shortage lasted more than one whaling season. Disturbance effects on caribou could disrupt sociocultural systems for an entire season or more; nevertheless, it is not expected that these disruptions would displace ongoing sociocultural institutions, community activities, or traditional practices for harvesting, sharing, and processing resources. Some cultural values, such as sharing, could be reinforced by shortages in the short term, but could be strained after several seasons of harvest shortages. Long-term harvest failures or the loss of a resource would irreparably strain the bonds of sharing and reciprocity that bind the community of Nuiqsut. The loss of the resources that Iñupiat people use to define themselves would further distance younger generations from their Iñupiat heritage and could cause profound changes in the community. Federal, NSB, and community-supported social programs with adequate funding would mitigate many of the sociocultural consequences of oil and gas development in the Planning Area. However, unavoidable repercussions to the communal practice of sharing of subsistence resources could occur.

4.8.14 Environmental Justice

The Environmental Justice Executive Order requires the consideration of the potential effects of proposed projects on Native subsistence activities. Noise and disturbance from routine development activities would be unavoidable. The most substantial unavoidable environmental justice effects on Native communities would be from exploration and development activities that reduced the populations or production of terrestrial mammals, water birds, and fish. These effects, which would be most prevalent under Alternative C, would primarily affect subsistence resources and would thus fall disproportionately on Native minority populations. Most other subsistence effects would be short term, local, and relatively minor, and would not be expected to raise environmental justice issues.

4.8.15 Coastal Zone Management

Activities occurring under the four alternatives are not expected to result in unavoidable adverse effects in the form of major changes in land use or conflicts with the ACMP, including the NSB Coastal Management Program. All four alternatives would likely result in short-term, unavoidable effects on subsistence activities from the change in land use in portions of the Planning Area from subsistence-based open space to industrial. To the extent that facilities would be sited and designed to minimize disturbance and the effects of an oil spill on the environment, conflicts with the statewide standards and the NSB policies are avoidable. It is expected that activities generally would conform to existing policies of local, state, and federal land use plans and coastal management programs.

4.8.16 Recreation Resources

Adverse effects to scenic quality, solitude, naturalness, and primitive/unconfined recreation from oil and gas exploration and development are unavoidable. These effects would be a direct result of exploration and development activities and facilities such as drill pads and pipelines. The areal extent of the effects would be limited to the viewshed and/or noiseshed of the development activities, leaving most of the Planning Area unaffected, but the impacted areas would lose their potential Wilderness characteristics for at least the life of the activity. Recent and future technological advances could make green trails and pads an avoidable impact.

Potential outstandingly remarkable values of the Wild and Scenic River eligible Colville River could be degraded by oil and gas exploration, development, and production activities, but the unavoidable adverse effects would be limited to the area(s) in close proximity to a pipeline or road crossing of the river. The effects would not alter the current status of unsuitability, but could limit the likelihood of a future change in that status.

4.8.17 Visual Resources

Unavoidable adverse effects to visual resources (i.e., the viewsheds and naturalness of the landscape) would occur from oil and gas exploration and development through the introduction of vertical lines, regular spacing, and a greater spectrum of colors. These effects would be a direct result of oil and gas exploration and development activities and facilities such as drill pads, roads, and pipelines. Recent and future technological advances could make green trails and pads an avoidable impact.

4.8.18 Economy

Most economic effects of oil and gas leasing, exploration, development, and production in the Planning Area would be considered positive effects by many people. Increases in employment and associated personal income would occur over the life of the exploration, development, and production activities. Revenue increases to the NSB, and to the state and federal governments, would occur during production years. However, these increases would be short term (less than 30 years), occurring only for the duration of the activities. Development activity would establish infrastructure that could enhance the future productivity of oil and gas exploration, development, and production.

4.9 Relationship Between the Local Short-term Uses and Maintenance and Enhancement of Long-term Productivity

This section discusses the short-term effects of the potential use of portions of the Planning Area for oil and gas exploration and development activities, versus the maintenance and enhancement of potential long-term productivity of the Planning Area’s environmental resources.

Short term refers to the total duration of oil and gas exploration and production activities, whereas long term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling occurs sporadically throughout the life of an oil or gas field, but also results in short-term, localized impacts. Activities during the production life of a field may result in chronic impacts over a longer period of time (25 to 35 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is also a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. Over the long term—several decades—natural environmental balances are expected to be restored.

Until more reliable data become available, the long-term effects of chronic or major spills of hydrocarbons cannot accurately be projected. In the absence of these data, it must be assumed that chronic spills or a major large oil spill could result in decreased long-term productivity.

4.9.1 Air Quality

The risk to air quality from development, production, and transportation from each of the alternatives would be similar to the risk from present and historic oil and gas development, production, and transportation. Short-term degradation of air quality related to construction, placement, and operation of exploration and production facilities would be the same as those for other oil and gas exploration and production facilities. Air quality is a renewable resource; and, when activities that produce emissions cease, the local air quality returns to its original natural condition.

4.9.2 Paleontological Resources

Because paleontological resources are nonrenewable, there is no difference between short-term and long-term impacts. The resource cannot recover from some types of adverse impacts. Once disturbed, the materials and information of paleontological deposits may be permanently compromised. Any destruction of paleontological sites, especially ones determined to have particular scientific value, would represent long-term losses. Any discoveries of paleontological resources as a result of surveys required prior to development of a lease would enhance long-term knowledge of the area and these resources. Furthermore, once paleontological deposits are disturbed and exposed, then natural erosion could accelerate the destruction of fossils. Exposed fossils also are vulnerable to unauthorized collecting and digging.

4.9.3 Soil Resources

Soils potentially affected by exploration practices cover very small areas, although up to 2,000 acres of soil would be directly impacted during development for construction of pads and roads. Additional soil could be lost if new gravel quarries are developed. Replacement of soils after well abandonment could allow soils to eventually re-establish. While the formation of soils is a very slow process, short-term uses are projected have very small long-term effect. Soils lost through the construction of permanent facilities would essentially be permanent.

4.9.4 Water Resources

Oil and gas exploration and development would result in both short-term and long-term effects to water resources. Construction activities that disturb stream banks or lake shorelines, temporarily block natural channels, and remove gravel would all cause short-term increases in erosion and sedimentation. Water removal could cause short-term changes in aquatic habitat. Permanent gravel roads and pads, airstrips, pipelines, and facilities constructed adjacent to or crossing streams and lakes would have long-term effects on water resources. Removal of these structures from streams and lakes after production ceased would restore drainage patterns and natural sedimentation processes. Long-term changes could occur where thermokarst erosion caused major changes in stream banks, and lake shorelines, and altered natural drainage patterns. Oil spills would have both short- and long-term impacts, especially to fish resources of Teshekpuk Lake and other fish-bearing lakes and streams.

Oil and gas exploration and development would result in both short-term and long-term effects to water quality. Construction activities associated with road and pad construction; culvert and bridge work in streams and lakes that disturbed stream banks or shorelines; blockages of natural channels and floodways that disrupted drainage patterns; and removal of gravel would all cause short-term increases in erosion and sedimentation. Water removal could cause short-term changes in aquatic habitat, although these impacts would be minimized by limiting water withdrawals to 15 percent of less of the total volume of the water body. Permanent gravel roads and pads, airstrips, pipelines, and facilities constructed adjacent to or crossing streams and lakes would have long-term effects on water quality. Oil spills would have both short- and long-term impacts on water quality, especially to fish resources of Teshekpuk Lake and other fish-bearing lakes and streams. The magnitude and duration of effects would vary with the type and extent of the activities.

Degradation of water quality from construction and operation of oil field(s), winter ice roads, and spills could have a long-term effect on isolated water bodies.

4.9.5 Vegetation

The effects of non-oil and gas activities on vegetation would be short term. However, the construction of well collars for exploration wells and the most severe impacts caused by vehicles during overland moves and seismic exploration would cause long-term affects on vegetation. All effects of oil-field construction on vegetation would be long term, though new oil spills and dust and gravel spray from vehicular traffic on the gravel pads would not occur after field abandonment. The recovery time for vegetation from a spill could last several years (Jorgenson 1997, McKendrick 2000), but it is not known how long changes to plant communities as a result of dust effects would persist. Although research indicates that natural plant communities can be restored to gravel pads (McKendrick 1997), especially if some silt-loam soil is added to the substrate, the time until recovery of natural canopy cover would be so long that the impacts might be considered permanent from a human perspective. Therefore, the long-term productivity of these localized areas would be reduced; however, these areas represent between 0.1 and 1 percent of the Planning Area. Placement of gravel drilling pads, roads, airstrips, staging areas, and docks, as well as construction of pipelines or the use of gravel mine sites, would permanently disturb or destroy vegetation unless sites were reclaimed.

4.9.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation, soils, and water resources. Please refer to the discussions for each of these resources for information on the relationship between local short-term uses and maintenance and enhancement of long-term productivity of wetlands and floodplains.

4.9.7 Fish

4.9.7.1 Freshwater and Anadromous/Amphidromous Fish

Impacts to fish resources and habitat would occur from oil and gas exploration and development. Most impacts would be short term and confined to small segments of habitat and localized components of the fish population. Although seismic surveys, construction activities, and oil spills are of particular concern, disturbances would be unlikely to result in decreased long-term productivity of fish populations. The exception would involve an oil spill in a waterbody with no migration pathways. Losses in a specific waterbody would be permanent if all individuals of a species were killed in a spill.

4.9.7.2 Marine Fish

Some marine fish could be lethally or sublethally affected by oil and gas activities in the Planning Area, but the number would likely be too small to be measurable at the population level. These effects are likely to be relatively short term, and with recovery expected within 3 years. A hypothetical very large spill (120,000-bbl) would affect an estimated 5 to 20 percent of the marine fish in the area. Full recovery from a spill of this size would be expected in 3 to 10 years, depending on the amount of oil reaching the nearshore area, and the amount of shoreline oiled.

4.9.8 Birds

Birds may experience short-term effects from any factors or activities that disturb their normal daily and seasonal pattern of activities. Of the routine activities associated with oil and gas exploration and development, helicopter, fixed-wing, and occasional marine support vessel traffic would have the greatest potential for disturbing birds. Helicopter flights would likely occur throughout the life of this project. Although much of the potential effect of air traffic could be avoided through compliance with lease stipulations and ROPs, aircraft could be required to fly at lower altitudes and cross critical parts of the coast during inclement weather. Under these conditions, disturbance of birds along the flight path could occur. Brant may be more affected by aircraft traffic, particularly helicopters, than other species (Derksen et al. 1992). Disturbances that affect survival rates of brant or other species of concern could have long-term effects on populations. The other sources of disturbance related to roads and facilities would result from vehicular traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. These disturbances would likely impact birds during the life of the field, but would unlikely continue after field abandonment; the effects of habitat loss or alteration may continue indefinitely.

4.9.9 Mammals

4.9.9.1 Terrestrial Mammals

Most effects on terrestrial mammals and their habitats from non-oil and gas activities and from oil and gas exploration would be short term. Short-term, localized effects could occur in the event of an oil spill, although it is expected that oil spills in the Planning Area would be small and would not likely affect a large area. Potential effects include mortality of individuals, physiological stresses in surviving individuals, reduction in the number of species or species populations in the affected area, changes in the distribution of species or individuals, and changes in behavior or migration patterns. Long-term, cumulative effects could occur if recovery from the short-term effects extended beyond the production life of the field. The potential effects of noise disturbance and terrestrial habitat alteration could also include short-term, localized effects such as mortality, stress, decreases in or redistribution of populations or species, and changes in survival patterns. Effects of oil and gas development on terrestrial mammals and their habitats would be long term (beyond the production life of the field); however those effects are not expected to be have impacts at the population level. Long-term biological productivity could be lost from areas used as facility sites.

4.9.9.2 Marine Mammals

Noise, disturbance, and habitat alteration from offshore construction activities and oil spills would temporarily affect some individual marine mammals and their habitats. These effects should be localized. Disturbances and altered habitat could result in local displacement, mortality, or stress in some species, or decreases or reductions in the local abundance of some species. Effects could possibly last over the long term if recovery from the short-term effects was extended beyond the field's estimated useful life.

4.9.10 Threatened and Endangered Species

Bowhead whales could be disturbed by noise from oil- and gas-related marine vessel traffic during years when the bowhead whale fall migratory path lies closer to shore than the mean migration distance (20 miles from 1982-2001; Treacy 2002a, b). Displacement would be temporary and short term, and could potentially occur annually over the life of the field. Aircraft traffic associated with development during the fall migration period potentially could disturb bowhead whales migrating very near shore. Since most of these activities are temporary, effects would be short term and potentially occur annually over the life of a field. In the unlikely event of a large oil spill, there could be long-term effects to the bowhead whale population from residual oil and continuing clean-up activities.

Spectacled and Steller's eiders could experience short-term effects from any factors that disturb their normal daily and seasonal pattern of activities and could continue for the life of the field. These effects would result from disturbances related to aircraft and vessel traffic. In addition, sources of disturbance related to roads and facilities would result from vehicular traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. These disturbances would likely impact birds during the life of the field, but would be unlikely to continue after field abandonment. Aircraft and ground-based research activities could impact threatened eiders for the life of the field. Many of these activities would likely discontinue after field abandonment, although some aerial surveys, to conduct long-term monitoring, would most likely continue after abandonment.

The effects of eider habitat loss or modification adjacent to roads and pads would likely be short term, although loss of habitat due to gravel placement would have a long-term effect that would likely last beyond field abandonment, unless habitat restoration was planned and implemented. Although nesting or brood-rearing habitat loss in the footprint of gravel infrastructure would have a long-term effect, other suitable habitat is widespread, and the effect on threatened eider populations would probably be minimal.

Potential eider mortality could result from collisions with vehicles or structures and would continue for the life of the field. Long-term effects could result if structures were not removed during field abandonment. However, eider mortality due to collisions with vehicles or structures has not been a major source of mortality in North Slope oil fields and would be unlikely to affect threatened eiders at the population level.

4.9.11 Cultural Resources

Because cultural resources are nonrenewable, there is no difference between short-term and long-term impacts. Cultural resources cannot recover from most types of effects. Historic structures could benefit from preservation and stabilization efforts prompted by nearby development. However, once disturbed, an archaeological deposit could never be returned to its original context. Any destruction of cultural resource sites would represent long-term losses. Salvage archaeology to recover remaining site data would generally result in the total destruction of the site, although the recovered data would effectively mitigate for loss of the site. Any discoveries of cultural resources made during surveys required prior to development of a lease would enhance knowledge of the history and early inhabitants of the region and serve to effectively mitigate further potential effects of activities in the area.

4.9.12 Subsistence

In the short term, the redistribution, reduction, or displacement of subsistence species could affect regional subsistence-harvest patterns. Such short-term effects would not be expected to have long-term consequences unless chronically imposed on the subsistence resource base of the region. Habitat destruction could cause a local reduction in subsistence species, a potential long-term impact to communities affected by such reductions. Increases in the amount of land used for infrastructure and development would reduce the amount of area suitable for subsistence hunting. Development along the coast could change the distribution of caribou in the summer, when the greatest numbers are harvested as the herds seek insect relief on beaches and in shallow lake and marine waters. Roads would increase access and competition for resources over the long term and could further affect subsistence harvests. Increasing human populations would require that more resources be harvested over wider areas to maintain the subsistence way of life. The potential for user conflicts could increase in areas where current uses overlap.

4.9.13 Sociocultural Systems

Increased population, industrial activity, and minor gains in revenues and employment could potentially disrupt sociocultural patterns in Native communities in the short term. Income and employment allocation disparities could increase, causing intra-community conflict. Short-term effects on subsistence resources would disrupt social systems if these effects were to occur repeatedly (chronic) over the lifetime of oil and gas activities in the Planning Area and on the North Slope. Habitat destruction would locally reduce or displace subsistence species, a long-term cumulative effect on the regional subsistence economy. As a result, sociocultural values and cultural institutions would be affected. Activities or policies that act against the values of the Iñupiat residents of the region would increase social stress and concerns in the community.

4.9.14 Environmental Justice

Any impact on subsistence resources that would have a chronic effect on the sociocultural system or subsistence resources over the lifetime of oil and gas activities (about 30 years) would disproportionately affect the Iñupiat people. Such an effect would only be expected to occur in the event of long-term population and productivity effects to caribou, fish, or water birds.

4.9.15 Coastal Zone Management

Land use could change along pipeline routes. If land use in parts of the Planning Area were to shift from subsistence-based activities to industrial activities, and if, after production ceased, use of the land reverted to subsistence, the effect would be short term. Long-term effects on land use could result if use of the infrastructure or facilities were to continue after the production life ended. Potential users could be other resource developers. Residents and nonresidents could become accustomed to the convenience of using existing facilities, such as roads.

4.9.16 Recreation Resources

Short-term use of portions of the Planning Area for oil and gas development could affect the long-term use and value of recreation and wilderness resources. Rehabilitation and removal of pads, roads, and facilities would be unable to restore the original condition of the land or its original recreation and wilderness value. If airstrips were not removed or rehabilitated, recreation opportunities in the area could be enhanced by increasing access.

However, scenic quality, naturalness, and primitive and unconfined recreation opportunities, which are essential to wilderness values, still would be negatively impacted by the presence of the airstrip.

River values that would be protected by designating the Colville River (the only eligible river) as a component of the national Wild and Scenic River system are free-flow, unpolluted waters, wildlife viewing, geology, archeology, and paleontology. The relationships between short-term uses and long-term productivity on these river values are more specifically addressed in the relevant sections addressing these values.

Oil and gas exploration, development, and production activities would constitute a short-term commitment of resources that could impact river values. For example, archeological and paleontological resources, which are nonrenewable, might be affected in the long term. The short-term commitment of resources would not affect the finding of nonsuitability on the Colville River, which is based on a combination of local political opposition and lack of federal control of the right bank of the river.

4.9.17 Visual Resources

Short-term use of portions of the Planning Area for oil and gas development could affect the long-term value of visual resources. Rehabilitation, removal, and revegetation of pads, roads, and facilities would eventually cause the viewshed to resemble a more natural condition. However, it is possible that the full value of the original scenic quality and viewshed would not be regained. Visual resources could still be negatively impacted by any remnants of oil and gas activities and by changes from the original landscape.

4.9.18 Economy

Economic benefits would accrue from production of oil and gas from federal lands. Economic benefits, including any decrease in the Nation’s dependency on foreign oil, would be short term. Increases in employment and associated personal income would occur over the life of the exploration, development, and operations activities. Revenue increases to the NSB and to the state and federal governments would occur during the production years. However, these increases would occur only for the duration of the activities. Development activity would result in infrastructure that in the short term could enhance future productivity of oil and gas exploration, development, and production.

4.10 Irreversible and Irretrievable Commitment of Resources

Irreversible or irretrievable commitments of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are the extinction of a species or the permanent conversion of a vegetated wetland to open water. In either case, the loss is permanent. The following section identifies irreversible and irretrievable commitments of resources that would occur if leasing occurred and resulted in oil and gas exploration, development, and production.

4.10.1 Air Quality

Air quality would be affected by well drilling, construction activities, and production. These effects would occur only during the life of the field(s). There would be no irreversible or irretrievable effects on air quality.

4.10.2 Paleontological Resources

Because paleontological resources are nonrenewable, any impacts would render the resource disturbance irreversible and the integrity of the resource irretrievable.

4.10.3 Soil Resources

Soils covered by gravel pads, roads, landing strips, and other infrastructure facilities would be lost with respect to their value (such as a medium for the growth of vegetation) as soils. Removal of structures, like gravel pads, could retrieve some soils, but would be unlikely. Soil in disturbed areas could re-establish over time, but soil development in cold climates is a very slow process. The desirable mitigation for soils would be to minimize the total area lost, through careful use of the surface, creative design practices, and use of shared facilities. Several of the lease stipulations and ROPs are designed to reduce the amount of soil impacted by exploration and development activities.

4.10.4 Water Resources

Thermokarst erosion along gravel roads and pads could result in major changes to streambanks and lake shorelines, and altered natural drainage patterns that would last long after the life of the field(s). While there would be no irreversible or irretrievable effect on water resources, the restoration of the natural drainage could take years after the field(s) were abandoned, equipment removed, and the roads and pads rehabilitated.

Thermokarst erosion along gravel roads and pads could result in degraded water quality that would last long after the life of the field(s), but the effects would not be irreversible. Oil spills could have an irretrievable effect on water quality if the spill could not be cleaned up and the oil sank to the bottom of the lake or contaminated the shoreline to the level that cleanup was not practical.

4.10.5 Vegetation

Permafrost-related geomorphic processes occurring on the ACP create a constantly changing landscape that influences successional patterns in plant communities. Most plant communities of Alaska’s North Slope are well adapted to these frequent changes (Billings and Peterson 1980; Bliss 2000; Funk et al. 2004). Therefore, changes in plant communities resulting from dust or snowdrift accumulations or the formation and draining of impoundments would not be considered irreversible. However, the burial of vegetation under gravel fill could be considered an irretrievable commitment of vegetation resources, as the potential recovery of vegetation on these pads could take 25 to 30 years or more (McKendrick 1997, 2000).

4.10.6 Wetland and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the ANS include vegetation, soils, and water resources. Please refer to the discussions for each of these resources for information on irreversible and irretrievable commitment of resources in relation to wetlands and floodplains.

4.10.7 Fish

4.10.7.1 Freshwater and Anadromous/Amphidromous Fish

Arctic fish in and near the Planning Area would be exposed to overland seismic surveys, construction-related activities, and spills associated with oil and gas exploration and development. A relatively small number of fish would likely be affected by these activities. Fish populations should not experience any irreversible and irretrievable effects associated with activities undertaken as a result of this amendment.

4.10.7.2 Marine Fish

While some marine fish could be lethally or sublethally affected by management actions in the Planning Area and would require up to 3 years for a full recovery, it is unlikely that these effects would be biologically measurable at the population level. The exception would be a hypothetical 120,000-bbl oil spill. Depending on the amount of oil deposited in the nearshore area during summer, and the amount of actual shoreline oiled, it is estimated that a 120,000-bbl spill could affect 5 to 20 percent of the marine fish population in the sale area (estimated 3 to 10 year recovery). Because full recovery would be expected following any oil spill, no irreversible and irretrievable commitment of resources should occur.

4.10.8 Birds

Some irretrievable and irreversible loss of habitat could occur from the placement of gravel for infrastructure in bird nesting or brood-rearing habitats. Loss of wetland habitat occupied by waterfowl and shorebirds could be particularly important. In most scenarios, alternate habitats would likely be available adjacent to developments, and any habitat loss would have a minor effect. Loss of individual birds through collision with facilities or structures could occur; however, such losses are not expected to have an effect on regional populations.

4.10.9 Mammals

4.10.9.1 Terrestrial Mammals

It is possible that caribou and other terrestrial mammals could be subjected to the direct and indirect effects of noise and movement of motor vehicles and aircraft, other human activities, oil spills, natural gas blowouts, or losses and deterioration of habitat because of facility developments. It is likely that such effects would lead to some permanent (irreversible) losses of these resources.

4.10.9.2 Marine Mammals

Seals, walruses, polar bears, and beluga whales could be subjected to direct and indirect effects of oil spills, disturbance caused by noise and movement of aircraft and vessels, and other human activities. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources.

4.10.10 Threatened and Endangered Species

For threatened and endangered species, any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of the species would probably violate the intent of the Endangered Species Act. Since the bowhead whale population is increasing and effects from noise would likely be temporary, irreversible or irretrievable losses would be unlikely. Any deterioration of the bowhead whale auditory environment resulting from noise-producing activities in coastal areas would last only as long as the causative activity.

Some irretrievable and irreversible loss of habitat could occur from placement of gravel infrastructure for oil and gas facilities in spectacled or Steller’s eider nesting or brood-rearing habitat. This loss of habitat could be permanent unless habitat restoration was planned and implemented during field abandonment. Impoundment formation adjacent to roads and pads could also create habitat for threatened eiders. Because alternate habitat would likely be available in areas adjacent to proposed development, any habitat loss would likely have a minor effect on threatened eiders.

Eider mortality could result from collisions with vehicles or structures during the life of the field. Any losses of individual eiders through collision with facilities or structure would be irretrievable, but would not be expected to affect eiders at the population level. If structures were not removed, long-term effects to eiders could result after field abandonment.

4.10.11 Cultural Resources

Cultural resources are nonrenewable, so any impacts would be irreversible, and the integrity of the affected resource would be irretrievable. Since most known cultural resources exist in a surface or near-surface context, burial by the construction of a gravel pad or road, while possibly not damaging in itself, would affect the cultural resource upon removal of the gravel. If subsurface cultural resources were encountered, as during the development of a gravel mine site, such resources could be damaged or destroyed. The loss of such cultural resource information would be irreversible and irretrievable. Salvage archaeology to recover remaining site data would generally result in the total destruction of the site, although the recovered data would effectively mitigate for loss of the site. Any discovery of cultural resource data as a result of surveys required prior to development of a lease would enhance long-term knowledge. Overall, such finds could help fill gaps in our knowledge of the history and early inhabitants of the area.

4.10.12 Subsistence

Many important aspects of Iñupiat society and culture are centered on subsistence activities (see Appendix J). Virtually every family in North Slope coastal communities participates in the hunting of the bowhead whale and the sharing of its meat and *maktak*. The activities associated with harvest of caribou, fish, birds, wolf, wolverine, and seals are only slightly less important to the cultural integration of the region as a whole, but they are of equal importance to the inter- and intra-community social organization, cultural identity, and the domestic economies of most households. The reduction or loss of the ability to harvest sufficient quantities of these resources would be an irreversible and irretrievable loss to the Iñupiat diet, to Iñupiat traditional practices of sharing and reciprocity, and to fundamental aspects of Iñupiat identity. If subsistence users were to abandon traditionally used harvest areas because of legal or perceived regulatory boundaries or contamination concerns at or near an oil or gas development, this abandonment would contribute to a loss of access, affecting the connection of Iñupiat subsistence users to traditional use areas.

4.10.13 Sociocultural Systems

Disruption of the traditional harvest of bowhead whales and caribou could constitute an irreversible and irretrievable loss to Iñupiat social and cultural values. The alienation of Iñupiat subsistence users from their homelands would be an irreversible and irretrievable commitment of resources, as land use patterns have shown that when oil and gas development activities take place in an area, other land uses are curtailed and land users excluded (Brown 1979; Pedersen et al. 2000). This connection to the land is one factor that constitutes Iñupiat identity, not least in terms of how one identifies oneself in Iñupiat society by area of residence, such as *Kuukpikmiut*, a person of the Colville River area. The contribution of oil and gas development in the Planning Area to the cumulative consequences of offshore and onshore energy development could, in conjunction with other processes of social change in the long term, lead to social and cultural conflicts within and between communities and contribute to the compromise of Iñupiat value systems. If the Iñupiat were to lose access to traditional use areas and culturally-valued sites in the Planning Area, or avoid them for cultural reasons, then sociocultural patterns could be affected; there would be a loss of continuity between generations and changes in sharing and reciprocity within and between communities as a result of a reduction in subsistence harvests.

4.10.14 Environmental Justice

Long-term population and productivity effects to caribou herds, fish populations, or waterfowl from oil and gas development could produce irreversible and irretrievable effects to subsistence resources. These effects would translate into effects on Native minority populations and thus raise environmental justice issues.

4.10.15 Coastal Zone Management

There are no anticipated conflicts with the statewide standards of the Alaska Coastal Management Program or the enforceable policies of the NSB Coastal Management Program. Development activity would result in the construction of infrastructure, but the majority of the infrastructure would be inside the boundaries of the Planning Area. Some infrastructure, such as pipelines, could be located outside the Planning Area, within the boundaries of the NSB, but such infrastructure could be removed after development ended.

4.10.16 Recreation Resources

There would be no irreversible and irretrievable commitment of recreation resources. Proper rehabilitation and removal of development pads and other structures would restore the perception of a natural environment. Wilderness values would be forgone in those areas affected by development for the duration of the development, rehabilitation, and recovery. Future eligibility for Wilderness designation would depend on the level of success of rehabilitation and recovery efforts after completion of petroleum production.

Irreversible and irretrievable impacts on Wild and Scenic River values on the Colville River are possible as a result of oil and gas exploration, development, and production activities, but the effects would likely be limited to a relatively small area near a pipeline or road crossing. The potential effects would not alter the finding of nonsuitability for the Colville River.

4.10.17 Visual Resources

There would be no irreversible or irretrievable commitment of visual resources. Proper removal, rehabilitation, and revegetation of development pads and other facilities would restore the perception of a natural environment. To the casual observer, viewsheds would appear natural.

4.10.18 Economy

Increases in employment and personal income would occur over the life of the exploration, development, and operation activities. Investment by the lessees and operators in oil and gas exploration and development activities in the Planning Area would represent a loss of opportunity to invest those monies elsewhere. Revenue increases to the NSB and the state and federal governments that would occur during production years would result in the irreversible and irretrievable commitment of those revenues. Development would result in new infrastructure that would be removed at the end of production.

4.10.19 Oil and Gas Resources

Oil and gas resources are expected to be leased, discovered, developed, and produced as a result of leasing in the Planning Area. The oil and gas resource estimates for each alternative considered in this amendment are presented in Table 4-5. For the highest case scenario (Alternative C and $30 per bbl of oil), it is estimated that approximately 2,488 MMbbl oil would be available for production. Should these resources be produced, they would be irretrievably consumed. In the unlikely event of a large oil spill, the oil spilled would be irretrievably lost.

4.11 Low-Probability, Very Large Oil Spill

4.11.1 Introduction

This section discusses the probabilities and potential effects of a very large oil spill in the Planning Area. In this Amended IAP/EIS, a very large spill is defined as greater than or equal to 120,000 bbl of oil. A very large oil spill is a low-probability event with the potential for severe effects. A similar analyses of a very large tanker or pipeline spill was included in Appendix B of the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998) and is incorporated here by reference. Various scenarios for large pipeline spills were analyzed in the Final EIS for the TAPS pipeline (USDOI BLM 2002a). Because very large spills happen so infrequently, there is limited historical data for use in statistical analysis and prediction.

The ADEC North Slope spill database for 1995 to 2003 (ADEC 2003) indicates that five very large volume spills have been reported for the North Slope oil fields since 1977, none of which were of oil or produced fluids. During that time the total oil production was approximately 1.6 x 10^{12} gallons (ADR 2004a). Thus, the probability of a very large volume oil spill occurring in the Plan Area approaches zero. This probability is extremely low for all hazardous materials combined.

The largest hypothetical spills would be of produced fluids from a well blowout. However, the largest spills in the ADEC 1995 to 2003 database are of seawater and produced water. The following very large volume spill impact assessment is based primarily on potential spills of produced fluids from a blowout.

4.11.1.1 Well Control Incidents

The record of Alaska North Slope well control incidents or blowouts is not validated, but is presented as the best available information. Although the State of Alaska does not maintain a database of North Slope well-control incidents, the Alaska Oil and Gas Conservation Commission maintains an internal documentation of blowouts in Alaska. Neither of the authors cited below (Mallory 1998; Fairweather E&P Services, Inc. 2000) was allowed to review the documentation. The Alaska Oil and Gas Conservation Commission assured Fairweather E&P Services, Inc., that no blowouts had been overlooked.

Two written reports regarding blowouts on the Alaska North Slope are available—Mallory (1998) and Fairweather E&P Services, Inc. (2000). Mallory (1998) presents the following data based on discussions with long-time Alaska drilling personnel with ARCO Alaska or BP Exploration Alaska (BPXA). In the period 1974 through 1997, an estimated 3,336 wells were drilled on Alaska's North Slope. Research conducted to date has documented six cases where secondary well control was lost with a drilling rig on the well. The documentation does not differentiate between exploration and development wells. No oil spills, fires, or loss of life occurred in any of the events (Mallory 1998).

Fairweather E&P Services, Inc. (2000) differentiated between a blowout and a well-control incident. A blowout was defined as an uncontrolled flow at the surface of liquids and/or gas from the wellbore that resulted from human error and/or equipment failure. Fairweather E&P Services, Inc. (2000) found 10 blowouts: the 6 blowouts that Mallory had identified and 4 blowouts that occurred before 1974. Of the 10 blowouts, 9 were gas and 1 was oil. The blowout of oil in 1950 was unspectacular and could not have been avoided, since there were no casings or blowout preventers available (Fairweather E&P Services, Inc. 2000). These particular drilling practices from 1950 would not be relevant today.

A third study confirmed that no crude-oil spills greater than or equal to 100 barrels occurred from blowouts between 1985 and 1999 (Hart Crowser, Inc. 2000). The record of oil spills less than 100 bbl from blowouts was not searched by Hart Crowser, Inc. (2000).

Two spills of volumes greater than 50,000 bbl from blowouts have occurred in federal waters since offshore drilling began in the U.S. The largest spill from a blowout in federal waters was 80,000 bbl from the blowout in Santa Barbara Channel in 1969; the other was in the Gulf of Mexico in 1970. Because there have been no spills greater than or equal to 120,000 bbl in U.S. waters from blowouts, worldwide historical spill data must be incorporated to estimate the chance of a very large spill occurring. The information used here is based on spills from countries that do not have the regulatory standards that are enforced on the OCS or BLM-administered lands. In addition, some drilling practices used elsewhere either are not practiced here or are against MMS and BLM-administered regulations.

From 1979 through 2000, five oil-well blowouts greater than or equal to 10 million gallons (238,000 barrels) have occurred worldwide (Oil Spill Intelligence Report 1996; Cutter Information Corp. 1997; DeCola 2001). The causes of the blowouts were either war or drilling practices that oil companies do not now use and are not allowed to use under MMS regulations in the U.S. During this same time period, there were roughly 471 billion barrels of oil produced worldwide (British Petroleum 2001). These data indicate that the rate of occurrence of blowouts greater than or equal to 10 million gallons is 0.01 blowouts per billion barrels produced. If this rate is applied to Alternative C for Planning Area, the estimated probability of one or more oil spills of 10 million gallons (238,000 barrels) is 0.026 over the lifetime of the project.

S.L. Ross Environmental Research Ltd. (1998) calculated the chance of an extremely large oil spill (greater than 150,000 bbl) from a blowout with an average number of wells from the Northstar and Liberty projects using worldwide spill frequencies would be similar to those presented in the preceding paragraph.

Scandpower AS (2001) completed a blowout-frequency assessment for the Northstar development project. This analysis modified statistical blowout frequencies to reflect specific conditions and operating systems for drilling at Northstar. The estimated blowout frequency for drilling into the oil-bearing zone and spilling greater than 130,000 bbl is 9.4×10^{-7}.

At North Star, the State of Alaska prohibits the drilling of new wells or sidetracks from existing wells into major liquid-hydrocarbon zones at drill sites under their regulation during the defined period of broken ice and open water. This period begins on June 13 of each year and ends when 18 inches of continuous ice cover are present for a half mile in all directions from the Northstar Island. This seasonal drilling restriction eliminates the environmental effects associated with a well blowout during drilling operations in broken ice or open-water conditions.

Although the drilling prohibition reduces the chance of a blowout during periods of broken ice and open water, the chance of a blowout occurring during these periods is not completely eliminated when oil is being produced.

As noted in the following section, the State of Alaska requires as a planning standard the greatest possible oil spill discharge that could occur from a blowout. Thus, this amendment evaluates the potential effects of a very large oil spill.

4.11.2 Blowout Assumptions

As described in Alaska Clean Seas Technical Manual, Volume 1 (Alaska Clean Seas 1999), the North Slope Spill Response Project Team (a joint industry-agency task force) specified that for oil spill planning purposes, flow rates to be used for wells in areas without adequate production history data (e.g., Planning Area) are estimated at 5,500 bbl/day. The North Slope Spill Response Project Team also specifies that for planning purposes, a 15-day blowout is to be assumed. In the Oil Discharge Prevention and Contingency Plan for the Alpine field, ConocoPhillips estimates a 7,500-bbl day flow rate for 15 days, for a total of 112,500 bbl. In this analysis, the 7,500 bbl/day flow rate is used, rounded up to 8,000 bbl/day for a total of 120,000 bbl for the 15-day period.

The potential impacts on specific resources are presented below. In each resource-specific analysis, the blowout hypothetically occurs in an area sensitive to that particular resource and releases crude oil into the environment for 15 days. For the scenario, the analyst places the blowout spill in the location most susceptible to the resource. The general environments into which the oil could discharge are tundra, ponds, lakes, creeks, rivers, and lagoons. The blowout could occur at any time of the year. The receiving environment could be solid ice, broken ice, or open water, as well as snow and open ground.

The following blowout assumptions are taken from oil discharge prevention and contingency plans from facilities on the Alaskan North Slope (PAI 2001; BP Exploration (Alaska), Inc. 2000, 2001a, b).

- The crude oil is assumed to be similar in composition to “Alpine field” crude oil.
- The theoretical facility is a 5-acre gravel pad.
- The gas/oil ratio ranges from 400 to 2,200 standard ft^3/bbl.
- The blowout spill rises into the air at an average rate of 300 bbl/hour (8,000 bbl/day divided by 24 hours).
- Oil droplets fall to the gravel pad and surrounding area in the direction of the prevailing wind.
- Assuming an Alpine field-like crude oil, approximately 30 percent of the 120,000 bbl evaporates into the air, leaving 84,000 bbl on or adjacent to the gravel pad and surrounding area.

The following figures are based on Alaska Clean Seas (1999) Tactic T-6, assuming a 6.3-inch pipe and the lowest and highest gas/oil ratios. The highest gas/oil ratio results in the higher values below. Of the oil falling to the surrounding environment:

- Eighty percent of the oil falls out from 300 feet (lowest gas/oil ratio) to 3,600 feet (highest gas/oil ratio) from the source, in a plume 100 feet (lowest gas/oil ratio) to 400 feet (highest gas/oil ratio) wide; and
- Twenty percent of the oil falls out from 3,600 feet (lowest gas/oil ratio) to 33,000 feet (highest gas/oil ratio) from the source, in a plume 400 feet (lowest gas/oil ratio) to 2,000 feet (highest gas/oil ratio) wide.

After 15 days from the start of the spill:

- 3,400 bbl remain on the gravel pad;
- 38,600 bbl have drained from the gravel pad into the environment; and
- 42,000 bbl have fallen to the surrounding environment (2,800 bbl/day).

4.11.3 Behavior and Fate of a Blowout Oil Spill During Various Seasons

During a blowout, oil would fall to the pad and surrounding area in a scattered pattern. Some of the oil falling to the pad would drain to the surrounding area. How the oil would behave after that would be dependent upon the season.

4.11.3.1 Winter

For a spill occurring during winter, oil would spread mainly on the surface of snow cover, ice, and/or frozen soil. No oil would enter open water as long as the ice remained solid. There would be little or no change in the oil's physical properties at very low temperatures and when buried under a snow cover. Blowing snow would tend to combine with pooled oil until the oil was effectively saturated with snow crystals.

The oil would not penetrate any ice surface. It would spread mainly on the surface of the frozen soil. It is unlikely to penetrate the lower layers of soil because the seasonal thawed layer would be absent (Chuvilin et al. 2001).

4.11.3.2 Fall Freezeup

Broken ice occurs in the Planning Area during fall freezeup and spring breakup. The scenario for this analysis assumes that oil would fall to the broken ice in a scattered pattern and would drain from the pad into broken ice in tundra ponds, lakes, streams, rivers, or lagoons. The ice would contain the oil somewhat and reduce spreading. Unless the oil was frozen into the ice, the evaporation rate would not change. Dispersion and emulsification rates would be lower in broken ice than in open water.

For a spill occurring during fall freezeup, the oil would freeze into the ice and slush before ice sheeting occurred. Winds and storms could break up and disperse the ice and oil until the next freezing cycle. These freezing cycles can be hours or days. In late spring and summer, this unweathered oil would melt out of the ice at different rates, depending on when the oil was frozen into the ice. In first-year ice, most of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period. About mid-July, the oil pools would drain into the water. Thus, oil could be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 mm thick, allowing evaporation of approximately 5 percent of the oil—the part of the oil composed of the lighter, more toxic components of the crude. By the time the oil was released from the melt pools on the ice surface, evaporation would have almost stopped, with only an additional 4 percent of the spilled oil evaporating during an additional 30 days on the surface of the pond, lake, creek, stream, or river.

4.11.3.3 Spring Breakup

For analysis, it is assumed that a spill occurring during spring breakup would have the same behavior and effects as a summer or open-water spill. At spring breakup, the ice concentrations are variable. With high concentrations of ice, oil would spread between ice floes. As the ice concentrations eventually decreased to less than three-tenths of the water surface area, the oil on the water would behave as an open-water spill, with local oil patches temporarily trapped by the wind against ice floes. Oil on the ice floes would move with the ice as it responded to currents generated by the wind (S.L. Ross Environmental Research Ltd. 1998).

4.11.3.4 Summer

This scenario assumes that oil would drain from the gravel pad onto the tundra and/or open water, including lakes, ponds, creeks, streams, rivers, or lagoons. If oil were to fall on a water surface, the oil would move with the direction of flow and/or the winds. On the tundra, during the summer, the oil would spread less because of the cover of vegetation. Oil could penetrate the lower layers of soil because of their thawed condition. Rain could also increase the penetration of oil into the soil. The oil could spread laterally if it reached a permafrost lens or layer (Chuvilin et al. 2001).

4.11.4 Effects of a Low-Probability, Very Large Oil Spill

4.11.4.1 Air Quality

A very large (120,000 bbl) oil spill would affect nearby air quality locally and temporarily. Air quality effects would be caused by emissions from evaporation and from any burning associated with the oil spill or with oil-spill clean-up activities. Typical emissions from blowouts or other large spills consist of hydrocarbons (VOCs). Only fires associated with blowouts produce other pollutants, such as NO_x, CO, SO_2, and particulate matter. The scenario for a very low probability, very large oil spill assumes that the release of crude oil would continue for 15 days. Therefore, VOCs would continue to be released from the spilled oil for that length of time. The VOC concentrations would be very low and would normally be limited to an area of 0.4 to 0.8 mi^2. Moderate or heavier winds would further reduce the VOC concentrations in the air. Those VOCs would likely evaporate almost completely after the spilling ceased. Air pollution would be limited because of atmospheric dispersion. Air quality effects from a very large oil spill should remain quite localized and very temporary.

Effects on air quality from air emissions likely would be only a very small percent of the maximum allowable PSD Class II increments. The concentrations of criteria pollutants in the ambient air would remain well within the air quality standards. Consequently, there would likely be only a minimal effect on air quality with respect to the standards.

4.11.4.2 Paleontological Resources

Impacts to surface and near-surface paleontological deposits would likely be greater for a summertime spill than for one that occurred during the winter. While contamination of the deposit would render much of the data recovery valueless, the clean-up procedures would create even greater impacts. Since paleontological resources are nonrenewable, the effects could be substantial.

4.11.4.3 Soil Resources

Oil spills of any size could impact soils by altering vegetation. The oil alone would decrease plant growth, but oil spills probably would leave the surface organic mat intact. Spill cleanup, however, would be more likely to damage soils. Cleanups are not always well controlled; heavy traffic and digging are common and can result in damaged soils. Cleanup of oil spills would mitigate impacts to soils only if the clean-up methods and operations were very carefully controlled to minimize surface disturbance.

4.11.4.4 Water Resources

A very large crude-oil spill could have serious impacts to streams and lakes. While the petroleum residue from a spill could be flushed from most streams within a few years, the impacts to lakes and ponds could persist for decades. Additionally, a very large spill could saturate the tundra mat with oil, limiting the amount of crude oil that was recovered, and considerably lengthening the time over which impacts could occur. A spill that occurred in the winter could have similar impacts, although the snow and cold temperatures might retard the crude-oil runoff into the watershed and somewhat limit the contamination. A spill that occurred during spring breakup or fall freeze-up could have the greatest impacts, since it would be extremely difficult, if not impossible, to contain the spill when ice was either breaking apart or forming into semi-solid slush pans or jumble ice. Spill cleanup in the watershed would involve containing the spill, diverting or isolating it within the water body, skimming off the oil, and treating the remaining oil-contaminated water and sediments. Prevention and rapid response with adequate removal equipment would minimize effects.

For spills during frozen conditions, it is anticipated that oil would not reach open water. Following contaminated snow and ice removal, water quality impacts from the residual oil would be very limited in extent. However, even small quantities of oil remaining after cleanup could result in lethal and sublethal toxicity levels in waters within the spill area for approximately 7 years.

During summer, flat coastal tundra develops a dead-storage capacity averaging 0.5 to 2.3 inches (Miller et al. 1980) that would retain 300 to 1,500 bbl of oil per acre. Even at high water levels, the tundra vegetation tends to act as a boom and vegetation and peat as a sorbent, allowing water to filter through, trapping the more viscous oil (Barsdate et al. 1980) and also making recovery of the oil more difficult. On the other hand, even small spills can spread over large areas, if the spill event includes aerial, pressured discharge. For example, in December 1993, an ARCO Drill Site line failed and 1 to 4 bbl of crude oil misted over an estimated 100 to 145 acres (Ott 1997). For a large spill during breakup conditions or the summer season, oil-spill response likely would recover the bulk of spilled oil. However, sufficient oil could remain to result in lethal and sublethal toxicity levels in waters within the spill area for approximately 7 years. In addition, equipment used to contain and recover spilled oil could damage the tundra surface, potentially leading to thermokarst erosion and causing local water quality degradation.

4.11.4.5 Vegetation

The only reported blowout of crude oil on Alaska’s North Slope occurred in 1950 (Fairweather E&P Services, Inc. 2000), and no crude oil was spilled off the pad during that blowout. There is no history of the effects of a very large spill of crude oil on North Slope tundra vegetation. Overall, past spills (of much smaller volumes) on Alaska’s North Slope have caused minor ecological damage, and ecosystems have shown good potential for recovery, with wetter areas recovering more quickly (Jorgenson 1997, McKendrick 2000, NRC 2003). It is estimated that a spill of 120,000 bbl would cover up to 1,500 acres, with 80 percent of the oil falling out on less than 30 acres. From these numbers it is assumed that most of the vegetation affected would be impacted. A percentage of the vegetation affected would likely suffer longer-term consequences, suggesting that recovery would take longer and might not be as complete.

4.11.4.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation soils, and water resources. Please refer to the discussions for each of these resources for information on the potential impacts of a very large spill.

4.11.4.7 Fish

Anadromous/Amphidromous Fish

As discussed in the analyses for the alternatives, oil spills have been observed to have a range of effects on fish; the specific effect depends on the concentration of petroleum present, the length of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive; Malins 1977; Hamilton et al. 1979; Starr et al. 1981). If lethal concentrations were encountered, or if sublethal concentrations were encountered over a long enough period, fish mortality would be likely. Such a situation could occur during a large blowout spill if the spill were to enter a body of water with restricted water exchange. The worst-case scenario would be a spill that occurred at fall freezeup or at the beginning of spring breakup in the lower reach of one of the large rivers that flows into Harrison Bay. Cleanup of a spill when ice was either forming into slush pans or breaking apart would be difficult. Petroleum residue would persist through the winter (and beyond) if the spill occurred at freezeup. Compounding this problem is the likelihood that freshwater fish of all life stages would be congregating in this habitat to overwinter. Craig (1989a) calculated that the lower portion of coastal plains rivers on the North Slope provide most of the overwintering habitat for freshwater fish.

Though lethal effects of oil on fish have been established in laboratory studies (Moles et al. 1979; Rice et al. 1979), large kills following oil spills are not well documented, probably because toxic concentrations are seldom reached (Rice 1985). In this scenario, where it is assumed that a large quantity of oil reaches numerous fish and the oil is not rapidly diluted, a substantial portion of the water body’s resident populations of fish species could be harmed or killed. Adults and juveniles might be able to avoid contact with oiled waters during a spill in the open-water season, but survival would be expected to decrease if oil were to reach a pool or series of pools isolated by ice and the fish were unable to avoid contamination. In the latter case, sublethal effects would be more likely to occur, and would include changes in growth, feeding, fecundity, and survival rates, and temporary displacement. Other possible effects would include localized reduction in food resources, and consumption of contaminated prey. Total fish loss would be dependent on the extent and duration of the contamination and the effectiveness of the spill cleanup. If the entire population of any given species in a drainage were spread out among overwintering sites in a river or adjacent lakes, the loss at any given site would not be expected to eliminate a population.

Marine Fish

A very large nearshore spill during the summer feeding period would likely result in moderate to high effects on some marine fish populations. Depending on the amount of oil deposited in the nearshore area during summer, and the amount of actual shoreline oiled, it is estimated that a 120,000-bbl oil spill would affect 5 to 20 percent of the marine fish population in the area. Both lethal and sublethal effects would be expected. Fishes farther offshore of the nearshore feeding area would likely not be affected. The occurrence of a very large spill during winter could have similar effects when released from the ice during the following spring. In either case, recovery would be likely in 5 to 10 years. If such a spill were to occur well offshore in summer, much of its effect would be reduced by weathering and the resulting reduction in the amount of oil reaching nearshore feeding areas. While the spill would still be expected to result in a moderate to high effect on some marine fish populations, its effect would likely be greatly reduced (estimated recovery of 3 to 5 years).

4.11.4.8 Birds

Effects of a Blowout Oil Spill on Birds

Throughout the summer and fall periods, many tens of thousands of long-tailed ducks, other waterfowl, loons, and seabirds are present for varying intervals in coastal lagoons and nearshore and offshore waters of the Beaufort Sea. Larger concentrations occur in areas east and west of the Planning Area than in areas offshore of the Planning Area (Johnson et al. 1993; Fischer et al. 2002; Ritchie et al. 2002). If a 120,000-barrel offshore spill were to occur in the Planning Area, when large concentrations of molting, staging, or migrating birds were present, thousands of birds could be contacted by oil, potentially resulting in a substantial loss of birds. A spill that spreads out of the Planning Area to adjacent coastal or offshore areas could impact a larger number of birds and could impact several thousand nesting or postbreeding common eiders concentrated near barrier islands and in coastal lagoons. Other species likely to be affected by a large oil spill include scoters, northern pintail, Pacific loon, phalaropes, and glaucous gull. Red-throated and yellow-billed loons, whose ACP populations are relatively small, also could be affected. Although fewer individuals would be expected to be affected by an oil spill in the waters offshore of the Planning Area compared to offshore areas to the east and west, large numbers of molting and staging geese and shorebirds could be affected in coastal areas of the Planning Area.

A large spill occurring in August or September, and affecting a substantial proportion of the thousands of Ross's gulls that gather east of Point Barrow to feed each fall (Divoky et al. 1988), could result in a substantial loss of this species, whose world population most likely does not exceed 50,000.

A terrestrial spill from a pipeline in summer may enter lakes and streams used by waterfowl and shorebirds and could affect foraging and resting habitat. Oil from the feathers of incubating adults may cover eggs, reducing oxygen transfer through the shell and causing embryo mortality. Direct mortality to adult birds could occur through hypothermia after contact with oil or by ingestion of oil.

Blowout During Open-Water Conditions

Although spill containment, recovery, and clean-up techniques under ideal weather conditions may be effective, these conditions may not exist during a spill incident and some loon, waterfowl, shorebird, and seabird habitats are likely to be contacted by oil. Individuals or groups of birds are widespread in their offshore distribution, ranging from the shoreline to 30 miles or more offshore. If a large spill is not contained before reaching areas of bird concentrations, hazing tactics may help to reduce the number of birds that may be affected by the spill.

Containment, recovery, and clean-up activities for a large spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. Persistence of oil in the environment would vary depending on weather conditions and speed of containment, recovery, and cleanup. The presence of such a workforce is likely to produce hazing effects, by displacing birds from the immediate area of the spill. If a reliable system of locating bird concentrations in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Displacement of female waterfowl with broods from coastal habitats by clean-up activity may have a negative effect if it prematurely forces them into the offshore marine environment where foraging may be more difficult for the ducklings. Disturbance of nesting sea ducks by onshore clean-up activities is not expected to have a major impact on their productivity unless disturbance happens in an area of concentrated nesting effort or to individuals with low and/or declining populations. Because of low nesting density of ducks along the coast, few nesting birds are likely to be displaced and potentially lose their clutches or broods to predators or exposure to weather as a result of disturbance by clean-up operations. Helicopter support traffic and human presence probably would be the most disturbing factors associated with oil spill clean-up activity.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, would likely to result in a substantial reduction of loon, waterfowl, and shorebird mortality from a large oil spill. Cleanup also would decrease the amount of oil available for uptake by bottom-dwelling organisms that are the principal food of sea ducks and shorebirds.

A 120,000-barrel oil spill in offshore waters of the Beaufort Sea could result in the loss of thousands of waterfowl and shorebirds utilizing habitats either in offshore areas or along the shoreline. Oil from an offshore spill that spread to areas adjacent to the Planning Area could impact more birds in those adjacent areas than in the Planning Area.

Blowout During Broken-Ice Conditions

Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Under these conditions the spill would be contained in a smaller area than a spill in open water, and fewer birds are likely to occupy broken ice unless areas of open water are available. However, Pacific loons, long-tailed ducks, king eiders, common eiders, and glaucous gulls have been observed in small areas of open water available under these conditions (Dau and Hodges 2003). Even after spring melting provides areas of open water, most arriving spring migrants likely would occupy overflow areas off river mouths, because those are available earlier and are in the vicinity of nesting areas. The hazing effect of clean-up activity or actively hazing birds to displace them from areas where oil is located may be counterproductive, because few alternative habitats are available to birds at this time. For sea ducks arriving via overland routes, the benefit of spill containment and cleanup would be minor until they begin reentering the marine environment following breeding. By this time, the oil would have weathered and would be expected to have minor impact to birds. Indirect effects resulting from intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Accumulation of oil in coastal marshes and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore areas. Prior to freeze-up, most sea ducks and other waterfowl and shorebirds are not likely to be present in great numbers, and oil present in areas with broken ice may have weathered and become less hazardous to birds. Long-tailed ducks, eiders, and glaucous gulls are at risk until later in the fall than most other species because they remain in the area longer than most other species.

A winter spill entering the environment during the ice-covered period could affect birds after the ice melts in the spring. Migrating loons and waterfowl concentrated in open water near river deltas or other nearshore areas could come in contact with oil or could feed on contaminated prey. Losses from a spill contacting terrestrial habitats would not be expected to result in substantial effects to bird populations.

4.11.4.9 Mammals

Terrestrial Mammals

For this analysis, it is assumed that a very large spill from a blowout would occur during the peak of the mosquito season within the TLH caribou insect-relief area north and east of Teshekpuk Lake. Any terrestrial mammals in the immediate vicinity of the blowout could be contacted by oil falling onto the surrounding tundra and open water. Loss of thermoregulation would not be a factor, except possibly in young caribou calves. Larger, more mobile animals such as caribou, bears, and moose would likely move out of the area affected by the blowout, reducing their exposure. Smaller, less mobile animals might not be able to move out of the affected area, resulting in greater mortality of these species. Some animals could be killed from exposure to toxins, either absorbed through the skin or ingested during feeding. Ingestion typically results in pulmonary aspiration that can be lethal or predispose the animal to infections. Terrestrial mammals would be temporarily disturbed or displaced by cleanup and site rehabilitation activities. At this time of year, TLH caribou would be aggregated into large groups for insect avoidance. If a blowout occurred in the vicinity of an aggregation, a relatively large number (100+) of caribou could be exposed to oil fallout. Movement of insect-harassed caribou in the vicinity of the blowout could be disrupted during the duration of the blowout and the following period of cleanup, reducing caribou foraging efficiency. If foraging efficiency was reduced enough to result in reduced weight gain, there could be greater over-winter mortality or a corresponding reduction in parturition the following year. This effect would only last for 1 season and would not result in long-term reduction in the population size unless followed or preceded by a few years of higher mortality or lower parturition from other factors. The amount of habitat affected by such a spill would be minimal when compared to the amount of caribou habitat available on the North Slope.

Effects from a Possible Very Large Blowout Spill in Marine Waters in the Colville River/Harrison Bay Area

For this analysis, it was assumed that a very large spill from a blowout would occur in the Colville River/Harrison Bay area. If the spill were to occur within Harrison Bay or along the shore during the summer open-water season, the spill would contaminate marine waters. Small numbers of spotted seals (fewer than 100) could be exposed to the spill. Smaller numbers of other marine mammals, such as ringed and bearded seals, polar bears, and beluga whales that generally occur offshore during the summer, could be exposed to oil if the spill were to spread offshore. If spotted seals were to be oiled and suffer lethal effects from the spill, the small population could take a few years or more to recover. Losses of other marine mammals to the spill would likely be small (a few individual polar bears to perhaps 100 or fewer individuals of the other species), with recovery of populations expected within 1 year.

Effects from a Possible Very Large Blowout Spill Onshore in the Colville River Delta/Harrison Bay Area

For this analysis, it is assumed that a very large spill from a blowout would occur onshore in the Colville River Delta/Harrison Bay area. If the spill were to occur near Harrison Bay or along the shore during the summer open-water season, some of the oil would contaminate marine waters. Small numbers of spotted seals (perhaps 10 to 30 animals) could be exposed to oil from the spill. It is unlikely that other marine mammals, such as ringed and bearded seals, polar bears, and beluga whales that generally occur offshore during the summer would be exposed to the spill. If 10 to 30 spotted seals were to be exposed to part of the spill and suffered sublethal or lethal effects, the population could take a few years to replace these losses.

4.11.4.10 Threatened and Endangered Species

Bowhead Whale

If a very large spill were to occur at a well located along the northern coast of the Planning Area or along a river tributary to the Beaufort Sea, oil could enter the nearshore marine environment and potentially be transported to offshore areas. Under most circumstances, contact with whales migrating through offshore waters during the open-water season would be brief. In some years, however, bowhead whales have been observed very near shore between Point Barrow and Cape Halkett during the westward fall migration. For example, 77 individuals were observed feeding near the shoreline between Smith Bay and Dease Inlet in September 2000 (Treacy 2002a). If bowhead whales were feeding in an area when spilled oil was present, contact could be prolonged and some of the oil could be ingested. It is not known whether a brief exposure, especially of volatile components, would have effects on lung or eye function.

During their spring migration, bowhead whales often are concentrated in the spring lead system as they move through the Chukchi Sea, past Point Barrow, and eastward through the Beaufort Sea. This behavior makes them vulnerable to any oil entering the spring lead system. For example, a large spill occurring in late fall or winter could become entrained in the pack ice and the oil could be released into leads when the ice melted. However, a winter spill would likely melt out in July, so it is not likely that oil would be melted out of the ice in time to contact spring leads during the whale migration that spring. Oil released in broken ice conditions would be more difficult to clean up and more likely to enter the spring lead system. During the fall migration, oil from a meltout spill would be somewhat weathered and the toxic hydrocarbons at least partially evaporated before the oil entered the water. As a result of the weathering, the spill would be less likely to cause respiratory distress or other effects to bowhead whales surfacing to breathe.

Effects of an oil spill on bowhead whales would include oiling of the skin, inhalation of hydrocarbon vapors or oil, ingestion oil or contaminated prey, fouling of the baleen, reduction of food supply, displacement from feeding areas, and possibly death. The effect of fouling baleen has not been investigated adequately; the long filamentous bowhead whale baleen may be prone to more serious fouling than the coarser baleen of some other species, thereby depriving bowhead whales of a greater degree of normal function. The number of whales contacting spilled oil would depend on the timing and duration of the spill, ice conditions, effectiveness of containment and clean-up operations, and the whales’ ability or inclination to avoid contact. Based on conclusions from studies that have examined the effects of oil spills on cetaceans, external exposure to spilled oil is unlikely to have serious effects on bowhead whales. Most whales exposed to spilled oil would likely experience temporary, nonlethal effects, although lethal effects to some individuals could occur.

Spectacled and Steller's Eiders

Male spectacled eiders, from mid- to late June to late July, and females, from late June to early September, may stage in offshore waters of the Planning Area prior to migration (TERA 1999; Fischer et al. 2002; Troy 2003). Some spectacled eiders would likely be affected by an oil spill in the waters offshore of the Planning Area. Oil from a winter spill that was released from the ice during spring break-up could affect migrating eiders in open water near river deltas; however, most spectacled eiders likely migrate overland in the spring and few birds would be affected. A summer spill could impact staging eiders prior to fall migration. The number of eiders affected potentially could total tens to low hundreds of individuals. Using average estimated spectacled eider density calculated from USFWS survey data in the central Beaufort Sea area from Harrison Bay to Brownlow Point, and average severity of spill-trajectory paths (and thus, exposure of birds to oil), a USFWS model estimated an average of only two eiders would be exposed to a large spill (5,912 barrels) within 30 days in July (Stehn and Platte 2000). However, in late July, one group of 100 individuals was observed, suggesting a potential for much higher mortality should a spill occur in an area of relatively high spectacled eider density. The greatest potential for spectacled eiders to be impacted by an offshore oil spill would occur in deeper offshore waters of Harrison Bay rather than in offshore waters to the east or shallower nearshore waters. An oil spill could also contaminate prey populations in eider foraging areas at any time of year that could result in secondary impacts on eiders, affecting productivity and/or survival. Likewise, negative effects of a spill on shoreline and coastal marsh habitat could affect eiders when the eiders are moving from onshore brood-rearing areas to the marine environment, or in subsequent years. Molting and staging spectacled and Steller’s eiders are known to use the lagoon systems in offshore areas of the Beaufort and Chukchi seas and Norton Sound. Hundreds or perhaps thousands of spectacled eiders could be impacted by an offshore spill that occurred in areas of high bird use such as Kasegaluk Lagoon and Ledyard Bay in the Chukchi Sea and Norton Sound.

A large onshore spill released in the Planning Area during the summer season could affect pre-nesting, nesting, and brood-rearing spectacled or Steller’s eiders. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for nesting, brood-rearing, or foraging, and oil entering freshwater aquatic habitats could spread more widely, including into river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers should eiders come in contact with oil, or by ingesting contaminated prey. Oil that may come in contact with eggs, either directly or through contact with partially oiled feathers of incubating adults, can negatively impact embryonic development.

Effects of Oil-Spill Prevention and Response

A spill that occurred during the summer open-water period would be expected to cause some Steller’s eider and spectacled eider mortality. Most mortality would likely occur offshore where concentrations of staging spectacled eiders are greatest. Containment, recovery, and clean-up activities for a large spill would be expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce in open water conditions would be likely to act as a general hazing factor by displacing any eiders from the immediate area of activity and potentially away from areas contaminated with oil. Active hazing may also help to reduce the number of eiders that may be affected by an oil spill by targeting specific birds or groups in danger of coming in contact with oil with specific hazing tactics. Special areas of concern include important foraging areas for spectacled eiders located in marine waters adjacent to the Planning Area in Smith and Harrison bays.

Containment and oil recovery operations following a large spill that entered the marine environment under broken-ice conditions at meltout or freezeup would be less effective than for a spill in open water. A spill during the ice-covered period or during broken ice conditions may be less likely to spread than a spill occurring during the open-water period and few eiders would be expected to occur in offshore areas during periods with ice coverage. Many spring migrants likely would occupy open overflow areas off river mouths that are open early and are near nesting areas; the most effective response could be to focus containment and clean-up efforts in such areas. During the broken-ice season, the hazing effect of clean-up activity or the active hazing of eiders to displace them from contaminated areas could be counterproductive, because there are few alternative habitats that could be occupied at this time. Since most spectacled eiders arrive in the area via overland routes (TERA 1999), the benefit of spill containment and cleanup would be greatest in nesting habitat. Indirect effects resulting from the intake of contaminated prey organisms could be higher under broken-ice than open-water conditions, because reduced cleanup capability could provide a longer interval for exposure and uptake by such organisms. Entrapped oil in coastal marsh and adjacent habitats could present a hazard to departing males after breeding and to females with young after nesting as they move to offshore waters. Few spectacled eiders are likely to be present in the offshore waters of the Planning Area by late September, and oil present in broken ice at this time likely would not impact many eiders.

Some mortality could also result in terrestrial or coastal habitats where post-breeding males or unsuccessful females or females with recently fledged young could be affected by an oil spill. An onshore spill in summer could enter lakes and streams used by eiders and could result in some mortality to nesting or brood-rearing eiders. As spectacled eiders nest in low densities, disturbance of nesting eiders by onshore clean-up activities would not be expected to result in large increases in nest abandonment or overall decreases in productivity. If clean-up activities were to displace females with broods from coastal habitats prematurely into the more saline offshore marine environment, it could result in decreased duckling survival. Helicopter support traffic and human presence would probably cause the greatest disturbance associated with oil-spill clean-up activity.

4.11.4.11 Cultural Resources

Because cultural resources in the Planning Area are located at or near the ground surface, a spill that occurred during the summer would have a greater effect on these resources than a spill that occurred during the winter. Oil spilled during winter, however, could impact cultural resources if the warm oil melted the snow and permafrost and impacted the underlying cultural resources. While the contamination of the cultural resources would render some of the data recovery valueless, the clean-up procedures would create even greater impacts. Since cultural resources are nonrenewable, the effects could result in loss of site integrity and loss of eligibility for the NRHP.

4.11.4.12 Subsistence

Effects on subsistence-harvest patterns from a 120,000-bbl oil spill could potentially displace and cause a functional loss of habitat to CAH, TLH, and WAH caribou. Effects to subsistence would occur as this important subsistence resource became unavailable or undesirable for use, or experienced long-term (more than 5 years) population and productivity effects. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals, injury to many more, and long-term contamination of the fatty tissues and possible chronic ill health for many of the whales exposed to the spill. Large numbers of spotted seals could be exposed to the spill and suffer losses, with population recovery taking several years, and hunters decreasing harvests of subsistence resources for many years due to contamination. Losses of other marine mammals should be smaller, with recovery occurring within 1 year. If a large spill were to occur when large concentrations of molting, staging, or migrating birds were present, tens of thousands of birds could be contacted by oil, representing a loss to regional populations and affecting subsistence and sports uses in the Y-K Delta as well as locations along the Pacific Flyway. A substantial portion of resident fish populations could be harmed or killed by a very large oil spill, and other populations could become contaminated. Access to subsistence hunting areas and subsistence resources and the use of subsistence resources could change if an oil spill reduced the availability of resources or altered their distribution patterns. Extra-regional efforts to acquire subsistence foods would be undertaken, possibly taxing the resources of other subsistence regions.

The communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut would be affected by a very large oil spill in the Planning Area. Even if few individual subsistence species were directly lost or displaced, a very large oil spill could potentially contaminate essential nearshore whaling areas and onshore terrestrial hunting and fishing areas, causing effects when the additive impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

4.11.4.13 Sociocultural Systems

Sociocultural systems in the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut could undergo long-term individual, social, and institutional stress and disruption from a 120,000-bbl spill. It is expected that considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., quotas), and the need to depend on the knowledge of others about environmental contamination (Fall 1992, McMullen 1993). Individuals and communities would be increasingly stressed during the time it would take to modify subsistence-harvest patterns by selectively changing harvest areas (if such areas were even available) and there would be increased costs and risks associated with travel and hunting in unfamiliar areas. Associated cultural activities, such as the organization of subsistence activities among kinship groups and the relationships among those who customarily process and share subsistence harvests, would also be modified or would decline.

A 120,000-bbl spill would be expected to affect individuals and social systems in ways similar to the effects of the *Exxon Valdez* oil spill. As shown by that spill, some individuals found a new arena for pre-existing personal and political conflict, especially over the dispensation of money and contracts. In the smaller communities, clean-up work produced a redistribution of resources, creating new schisms in the community and increasing social stresses. Many members of small communities were on the road to sobriety before the spill; after the spill, some people began drinking again, leading to the re-emergence of numerous alcohol-related problems (such as child abuse, domestic violence, and accidents). Institutional effects included additional burdens on local governments, disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflict, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders from confronting environmental degradation and death, and violation of community values (Endter-Wada 1992). Post-spill stress resulted from the seeming loss of control over individual and institutional environments, as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe 1990). Attempts to mitigate social effects were often ineffective because of concerns over litigation, causing a reluctance to intervene out of fear that these actions might benefit adversaries in legal battles (IAI 1990b, 1998; Human Relations Area Files, Inc. 1994; ADFG 1995). In response to spill hazards, there has been a resurgence in traditional strategies for responding to resource shortages, which in traditional times, and following the spill, resulted in an increase in sharing, a renewal and strengthening of social connections with extended family members and friends, and a cooperative approach to subsistence activities within and between the most affected communities.

4.11.4.14 Environmental Justice

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area potentially most affected by Planning Area exploration and development. An oil spill could affect Iñupiat Natives because they rely on subsistence foods and there could be cumulative effects to subsistence resources and harvest practices. The greatest level of effects would be experienced by the Iñupiat communities of Barrow and Nuiqsut.

In the unlikely event that a large spill occurred and contaminated essential nearshore whaling areas and onshore terrestrial hunting and fishing areas, major environmental justice effects could occur, stemming from contamination of the shoreline, tainting concerns, clean-up disturbance, and disruption of subsistence practice. Oil-spill contamination and cleanup could potentially displace and cause a functional loss of habitat to CAH, TLH, and WAH caribou, as well. Such impacts would cause damage to subsistence resources, which would result in disproportionately high effects on Alaskan Natives. Oil-spill contamination of subsistence foods would be the main health-related concern. Most potential effects to subsistence resources and subsistence harvests would be mitigated to some extent, though not eliminated.

4.11.4.15 Coastal Zone Management

A very large spill would be very unlikely. If a spill of this size were to occur, the spill itself and the resulting clean-up activities could have effects on one or more subsistence resources and access to those resources in the vicinity of the spill.

The NSB Coastal Management Program policies relate to impacts that are “likely and cannot be avoided or mitigated” and “development that will likely result in significantly decreased productivity of subsistence resources of their ecosystems.” An oil spill of this size would be accidental and the probability of such an event is very low. Therefore, it is not considered to be a “likely” event, and would not introduce conflict with policy standards.

The NSB CMP Best Effort Policy 2.4.5.1(b) states that access to subsistence resources can be restricted when there is no feasible and prudent alternative. This policy could pertain to clean-up activities. If it is determined that there are no feasible and prudent alternatives to these activities, there would be no conflict with this policy.

Based on the low probability of an oil spill event of this magnitude, and on compliance with existing regulations for spill prevention and response, existing management practices, and proposed lease stipulations and ROPs, no conflicts with CMP policies are anticipated.

4.11.4.16 Recreation Resources

The impacts to recreation and wilderness resources would primarily relate to reductions in aesthetic values and naturalness associated with visible oil sheen and residues on vegetation and water. The effects on recreation opportunities would be short term in nature and would dissipate as cleanup and rehabilitation proceeded. Effects on wilderness values would depend on the care taken with during the clean-up process. If the scars on the landscape from clean-up activities were effectively rehabilitated, the long-term effect on potential for Wilderness designation would be minor.

The likelihood of a large spill affecting the Colville River would depend on where oil and gas development occurred. A large oil spill could possibly impact water quality and outstandingly remarkable values, particularly wildlife, archeology, and paleontology, and, to some extent, recreation and geology. Impacts on archeology, paleontology and geology would likely depend on the care taken during clean up of the spill. Recreation values would recover over time. Such impacts would not change the determination that the Colville River is not currently suitable for designation as a Wild and Scenic River.

4.11.4.17 Visual Resources

A very large spill that occurred along the shore during the summer open-water season would have little effect on visual resources overall, as the spill would be confined to rocky beach areas or the immediate shoreline vegetation. The occurrence of a very large spill during the winter could have a similar effect if it were released from the ice during the following spring breakup. If a very large spill were to occur onshore in summer, visual resources would be impacted by the visible oil and the resulting damage to the underlying vegetation. However, spills would most likely occur on already disturbed areas such as drill pads and production areas and would not greatly increase the area already visually impacted.

4.11.4.18 Economy

No additional employment would be generated from cleanup of very small spills. Even larger spills of up to 1,000 bbl may not generate many additional jobs. Onsite workers doing other operations and other response personnel from the North Slope would clean up most small to medium-sized spills.

The estimate of employment used in this analysis for a very large spill of 120,000 bbl is based on the most relevant historical experience of a spill in Alaskan waters—the *Exxon Valdez* oil spill of 1989. The employment estimate is based on a ratio of workers to barrels spilled in the *Exxon Valdez* spill. The *Exxon Valdez* spill was 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers doing direct cleanup work in relatively remote locations. Smaller numbers of clean-up workers returned in the warmer months of each subsequent year until 1992. The Planning Area spill scenario assumes the spill would occur on land, not near the Beaufort or Chukchi seas, and not on possible drainage systems near and leading to those seas. If the spill occurred on land not near a sea, the number of workers could be less than the proportional effort to clean up the *Exxon Valdez* spill. If the spill occurred on a drainage system near a sea, then the clean-up effort would likely be close to that required to clean up the *Exxon V*aldez spill. Based on the experience of this spill, an oil spill of 120,000 bbl would generate approximately 5,000 jobs for 6 months in the first year, declining to zero by the third year following the spill.

In the case of the *Exxon Valdez* spill, numerous local residents quit their jobs to work on the cleanup, often at substantially higher wages, which generated inflation in the local economy (Cohen 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased by 25 percent in some cases to 6-fold in others, and inflated rents continued into 1990. The NSB would not experience similar inflation effects because cleanup activities would be managed and staged out of existing enclave-support facilities. The number of workers actually used to clean up a possible 120,000-bbl oil spill would depend on a number of factors, including which procedures were called for in the oil-spill contingency plan; the level of preparedness (equipment and training) of the entities responsible for cleanup; how efficiently the cleanup activities were executed; and the degree of coordination between the numerous responsible entities.

4.11.5 Comparison of Alternatives

Under the various alternatives presented in this amendment, the risk of the occurrence of a very large spill and the likelihood that such a spill would contact specific resources would vary. The risk of a very large spill would be different under each alternative because the projected level of oil and gas activities and production would be different. The likelihood of a very large spill contacting specific resources would be different under each alternative because the area available for oil and gas leasing would be different. The potential impacts of a very large spill would not differ among the alternatives.

The likelihood of a very large blowout spill occurring would be highest under Alternative C because the greatest number of wells and the greatest volume of production are projected under that scenario. The likelihood of contact with surface resources would vary by resource. In general, the likelihood of contact would be highest under Alternative C because the greatest area would be made available for oil and gas leasing, exploration, and development.

Under Alternative B, about 20 percent fewer wells are projected to be drilled and about 20 percent less oil is projected to be produced than under Alternative C. Given these scenarios, it is assumed, therefore, that the risk of a very large blowout spill would be about 20 percent less under Alternative B than under Alternative C.

Under the No Action Alternative A, about 70 percent fewer wells are projected to be drilled and about 75 percent less oil is projected to be produced than under Alternative C. Given these scenarios, it is assumed, therefore, that the risk of a very large blowout spill would be about 75 percent less under the No Action Alternative than under Alternative C.

4.12 Possible Permanent Roads

4.12.1 Scenario for a Possible Permanent Road Within the Planning Area

The scenarios for the alternatives evaluated in this amendment assume that permanent roads supporting oil and gas operations within the Planning Area are unlikely beyond that which ConocoPhillips currently proposes and that ice roads would be built to support oil and gas activities within the Planning Area.

A permanent road within the Planning Area would not be economically feasible under current economic and technological conditions. New oil and gas discoveries, changing economics, developing technologies, material availability, and the time constraints on ice roads are all factors that might influence the feasibility of "roadless" development versus the use of permanent roads.

The use of ice roads has logistical limitations. Heavy equipment cannot begin construction of ice roads until snow and permafrost reach sufficient depth to protect the tundra surface. Construction of ice roads is a time-consuming process, as the road alignment must be surveyed, permits for water use obtained, and the ice built up layer-by-layer. The time needed to construct an ice road of many miles to a drill site and the time needed to move heavy equipment back along the ice road before spring breakup reduce the amount of time available for winter drilling activities. Because of these time constraints, the feasible limit for use of ice roads is 50 miles over land and 100 miles over the bottomfast ice zone offshore. For production activities, an ice road would need to be constructed each year and alternate access (e.g., aircraft landing strip) would be needed to support operations during the summer.

Staging facilities could be established within the Planning Area. It would also be possible for lessees to store equipment year round in the existing oil fields. It is extremely costly to build ice roads over long distances, and the timing of when construction can begin is weather-dependent and unpredictable. While building a permanent road from staging facilities to possible drill sites would also be very expensive and difficult, such a road could be built.

For this analysis, the following assumptions are made for a possible permanent road within the Planning Area:

- The hypothetical road would be a 75-mile road from Nuiqsut to the northeastern part of the Planning Area (the high oil and gas potential area);
- Forty-eight thousand cubic yards (yd^3) of minerals materials would be required for each mile of road (a total 3.6 million yd^3 for a 75-mile road);
- Deposits with suitable quantities of mineral materials (sand and gravel) have been identified near or within the Planning Area (Clover Potential Gravel Source and ASRC site; USDOI BLM 1981), but the amount of material projected to be available at these two sites would not be sufficient to meet existing needs and those of the proposed road; thus materials would have to be brought to the road-construction site by barge and/or truck via ice roads;
- Interlocking mat systems might be used for construction of the road; these materials would have to be brought to the road-construction site by barge and/or truck;
- Four and one-quarter acres would be covered by each mile of road;
- Bridges would be required for crossing of major rivers; and
- The road would be funded and built by lessees and closed to the general public (i.e., the road would be for use by the oil and gas industry and local access only).

4.12.2 Scenario for a Possible Permanent Road Connecting Northeast National Petroleum Reserve – Alaska to Outside of the Planning Area

The scenarios for the alternatives evaluated in this amendment assume that a permanent road connecting Planning Area oil and gas fields to existing oil-field infrastructure to the east (e.g., Nuiqsut, Kuparuk field, or Alpine oil field) is unlikely. The BLM believes these scenarios are realistic. The 1998 Northeast IAP/EIS prohibits permanent roads connecting Northeast National Petroleum Reserve – Alaska facilities to an outside road system. Lease Stipulation 48 for the Northeast National Petroleum Reserve – Alaska states, “Permanent roads (i.e. gravel, sand) connecting to a road system or docks outside the Planning Area are prohibited, and no exceptions may be granted” (USDOI BLM 1998).

A permanent road across the Planning Area would not be economically feasible under current economic and technological conditions. However, the ADOTPF is proposing to construct an all-season gravel road from the Spine Road at the far western terminus (near the Tarn development) of the Kuparuk River Unit road system and proceed westward to a crossing of the Colville River 3 miles south of Nuiqsut. The road would ultimately link to the community of Nuiqsut. The project would also include development of one or more material sites in the area.

4.12.3 Effects

4.12.3.1 Air Quality

The construction of a permanent road would have a very minor favorable effect on air quality by eliminating the repetitive yearly construction and time-concentrated heavy use of ice roads. Some air quality effects would occur during the construction of the road from emissions from heavy equipment and vehicles used in the road-building work. Some effects would occur from subsequent vehicle use of the road. All of the emissions are expected to be very localized and temporary, except possibly dust. Road construction crews could reduce dust during construction by moistening the exposed surface. Similarly, moistening the road surface during periods of heavy use would reduce blowing dust. Air quality should remain well within ambient air quality standards and PSD limits.

4.12.3.2 Paleontological Resources

The greatest potential impact in the Planning Area would be the construction of a permanent road(s). It is very likely that the road(s) would be built from locally or regionally available mineral material that, because usable deposits of mineral material are rare in the Planning Area, but are also the most common preservation medium of fossil remains, it is very likely that the deposits from which the material would be mined would contain Pleistocene vertebrate fossils and possibly Cretaceous-age vertebrate fossils. These types of paleontological remains are much rarer and of greater value than marine invertebrate or plant fossils. Paleontological resources are nonrenewable. The mining of mineral materials could either cause them to be destroyed or remove them from their natural context, thereby compromising or negating their scientific value. Even if the mineral material were not mined within the Planning Area, it would have to come from somewhere nearby, adding to the possible cumulative impacts within the region.

The construction of a 75-mile-long road would bury the surface of the route with approximately 48,000 cubic yards of mineral material per mile and cover a total area of roughly 320 acres. The 320 acres is a very small portion of the Planning Area. However, the road is not a block area but rather a transect across a portion of the Planning Area. While the total area affected is the same, the impact of a 75-mile-long road is potentially much greater than that of a block area, simply because the road traverses an extensive segment of the landscape rather than impacting a single, constrained locale. Construction of the road with an interlocking mat system rather than mineral material would decrease potential impacts to paleontological resources to some degree because no mineral material deposits would be mined. However the impacts of laying down the mat system across the landscape would be equal to or possibly greater than that of laying down a roadbed comprised of mineral material. While deeply buried paleontological deposits would be protected from the impacts associated with construction of a permanent road, near-surface and surface remains would not.

It is likely that during surveys of probable road routes and mineral material sources, conducted before the start of construction, many of the surface (and some of the near-surface) paleontological remains would be identified, allowing most of the known locales of such remains to be avoided. Since, paleontological resources are not ubiquitous in the Planning Area and it is impossible to predict their location on the landscape to any meaningful degree, it is extremely difficult to assess the probability of impacts to the paleontological resources that could result from the construction of a permanent road. The route and location of the road(s) as well as the value or significance of the resource, information that is not available at this time, are needed to assess the level and degree of potential impact. With these limitations in mind, it is assumed that the probability of physical impacts to valuable paleontological resources resulting from road construction would be a reasonable possibility, though not a likelihood.

4.12.3.3 Soil Resources

The extraction of mineral materials for road construction and subsequent burial of soils by permanent roads would likely result in the permanent loss of soils in those areas that were directly affected. Permanent roads could also have detrimental effects on soils because of changes in stream banks, blockage of natural drainage patterns, and thermokarst erosion. Blockages and damming can increase soil loss through the cutting action of cold water during periods of high water flow. Blockages and damming can result in the thermal erosion of ice rich soils. These losses would amount to a permanent and irretrievable loss of soil resources.

The construction of a 75-mile-long road would result in the direct loss of about 320 acres of soils buried by the road. The area of direct impact (as a proportion of the Planning Area) is very small, less than 0.01 percent. A 18-mile road east of the Planning Area would result in soil losses of about 75 acres. Although the use of an interlocking mat system would reduce the need for mineral material, it would not reduce the overall area of soil resources loss.

Over the long term, it is possible that the construction of roads could reduce overall cumulative soil impacts. Traditionally, there has been unregulated and dispersed low-technology overland summer travel by local residents in the National Petroleum Reserve – Alaska. The application of new technology to traditional travel can cause problems for soils. For example, the use of off-highway vehicles, as economic conditions change and human population increases, has a greater impact on the soil than walking, the mode of transportation that OHVs replaced. A well-planned, permanent road system could have the net effect of increasing the opportunities for exploration, development, and individual access to the land (some of which is private) and could limit the overall impact to soils outside the acres directly affected by road construction.

4.12.3.4 Water Resources

The effects of permanent gravel roads on water could include disturbance of streambanks or shorelines and subsequent melting of permafrost (thermokarst); blockages of natural channels and floodways that disrupt drainage patterns; increased erosion and sedimentation; and removal of gravel from riverine pools, lakes, and floodplains (Walker et al. 1987a, b). A gravel road could create water impoundments and thermokarst erosion—equivalent to approximately twice the area directly covered by the gravel—up to 800 acres.

Unlike ice roads, gravel roads and pits would create long-term impacts over the life of the field(s). Since gravel roads could severely impact natural drainage patterns (creating flow diversions, impoundments, and thermokarst erosion), limiting the length of permanent roads and requiring that they have approved drainage plans would help to reduce impacts to water resources. Limiting development on floodplains and wetlands would ensure compliance with Executive Orders 11988 and 11990 that direct federal agencies to minimize the destruction, loss, or degradation of floodplains and wetlands.

The road could affect water quality in several ways, depending primarily on the type of construction (i.e., gravel versus an interlocking mat system). As explained below, roads on mats would probably alter some ponds and streams up to 800 acres for several years, causing a measurable (though minor) effect on water quality. Gravel roads would block some down-slope movement of water, creating small impoundments for several decades, and the dust from gravel roads would increase local water turbidity for as long as the road was heavily used.

An interlocking mat system has been used for temporary drill pads on the tundra. Two advantages of the system are that water turbidity would not be a problem as it would from gravel construction, and the impact on the tundra would probably persist for a relatively short period of time (compared to gravel fill). The duration of the impact is hard to determine because mat systems have apparently not been used for several years in one place. A mat system without a very effective insulation layer would probably increase the summer soil temperature under the mats over a period of years. Increased summer temperature would cause some melting of the tundra permafrost (or thermokarsting), leading to the formation of some new ponds and streams, which could influence the permafrost temperature further. The duration of impact of ice pads that have been insulated and used for more than one winter is only a few years (McKendrick 2000). A mat road of about 75 miles in length would create some new ponds and streams within about 4.25 acres per road mile (or about 320 acres) for a few years.

If the roads were constructed with gravel (usually about 5 to 7 feet thick), there would be almost no effect on the permafrost temperature, but there would be other effects. The assessment for the 1998 Northeast IAP/EIS concluded that the primary water-quality effect from construction and placement of gravel structures would be related to up-slope impoundment of water (USDOI BLM and MMS 1998). If standard North Slope construction practices were followed, culverts would be used to reduce impoundment, but roads might block some down-slope movement of water, creating small impoundments and, as noted by McKendrick (2000), drying the down-slope substrate. The impoundment effect would be very localized, but would persist as long as the gravel fill (for several decades).

Gravel roads also would also likely increase water turbidity, for two reasons. Culverts tend to concentrate flows that would otherwise be dispersed over a wider area—the concentrated flows being more likely to cause erosion of ice-rich soils—and, consequently, might increase turbidity (as explained in USACE 1997b). Secondly, dust fallout could also increase water turbidity. The fallout from heavily used gravel roads can be substantial; for example, up to 10 inches of dust was measured next to a major North Slope road (McKendrick 2000).

4.12.3.5 Vegetation

The impacts of permanent roads on vegetation would be similar to those from gravel pads and roads within oil field developments, as described in the analyses for the alternatives. These impacts would include the destruction of vegetation as a consequence of direct burial under gravel and the alteration of plant species composition in areas immediately adjacent to the road. The latter would be a consequence of dust or gravel spray and changes in moisture regimes from drifted snow or the blockage of natural drainage patterns.

A 75-mile road within the Planning Area would bury about 320 acres of land and alter the adjacent vegetation on about another 700 acres. As long as roads and other developments were sited to avoid populations of rare plants, they would not be likely to affect the continued existence of any plant species or community types.

4.12.3.6 Wetlands and Floodplains

Biological resource areas that would be classified as having the function and value of wetlands and floodplains on the North Slope included vegetation, soil, and water resources. Please refer to the discussions for each of these resources for information on how they could potentially be impacted by permanent roads.

4.12.3.7 Fish

A road connecting the Planning Area to Nuiqsut could result in impacts to freshwater fish. Potential impacts would be related to gravel extraction, disruption of fish movements due to altered flow patterns, and sedimentation and contamination of habitat.

Material sites (for gravel extraction) needed for construction of roads have not been identified in the Planning Area. A potential source would include river floodplains and channels. Given that the road would likely cross rivers close to overwintering and spawning habitat (lower reaches of major rivers), gravel removal from river beds could result in localized loss of spawning and overwintering habitat (loss of suitable substrate and overwintering pools). Road construction would have the potential to alter flow patterns to, and within, waterbodies. Bridges, culverts, low-flow crossings, and the road itself could interfere with fish migrations to spawning, feeding, and overwintering sites if improperly designed. Concerns related to road placement include diverting or eliminating flow from small tributaries that connect lakes or connect lakes and rivers. Potential loss of migratory capacity could stress or kill fish if they were unable to migrate to food-rich habitat in the summer, reach spawning areas, or move into overwintering habitat. Another potential impact during road construction is erosion and subsequent instream sedimentation. Direct threats to fish from sediment could include loss of physical habitat and decreased reproductive success. Embedded sediments could fill interstitial spaces and essential winter habitat used by juvenile fish. Filling of pool habitat would further limit overwintering sites for adult and juvenile fish. Developing eggs could be smothered and newly hatched fry could be killed by suspended sediment, which would prevent emergence from spawning gravel and interfere with respiration. In instances where stream reaches were aggrading due to heavy sediment loading, physical habitat would be further degraded when flows were redirected and eroded channel banks. Once built, a road would increase the chance of contaminant spills and subsequent impacts to aquatic habitat and resources. While impacts from gravel extraction, sedimentation, and altered flow patterns should be minor if adequate controls were in place, potential impacts from contamination would exist for the life of the road.

Marine Fish

The effect of a permanent road on marine fish would depend on the road's location, size, and design characteristics. Construction of a road in nearshore waters could affect the movement of some coastal marine and migratory marine fish, since they commonly feed and migrate in nearshore waters during the summer months. However, road construction would be expected to occur on land, and would have minor to no effect on marine fish. While an onshore road could affect some individual marine fishes, either directly (e.g. burial of nearshore marine habitat), or indirectly (e.g. increased turbidity), an onshore road would be unlikely to have a measurable effect on marine fish populations. If some portion of the road were to extend into marine waters, engineering it to provide for the unrestricted movement of nearshore marine fish should reduce the effects to fish in the immediate area of the road to short-term avoidance effects during the construction phase, with only minor effects expected on fish populations. Otherwise, marine fish in the vicinity of the road would likely be affected by restrictions in access to feeding and migrating areas.

4.12.3.8 Birds

The route of a permanent road connecting Nuiqsut or Barrow with oil field infrastructure would be likely to pass through or adjacent to important breeding habitat in the Planning Area for loons, waterfowl, and seabirds. A route from Barrow or Nuiqsut through the Goose Molting Habitat Area north of Teshekpuk would have the potential to cause disturbance effects that could impact high population density areas for greater white-fronted goose, brant, northern pintail, red-throated loon, Sabine's gull, and large shorebirds. Canada and snow geese also use this area during the molting period. A road located on tundra east of Teshekpuk Lake could impact high use areas for tundra swans, northern pintail, long-tailed ducks, and king eiders. A permanent road west of Teshekpuk Lake could impact high use areas for large shorebirds, Pacific and yellow-billed loons, tundra swan, and northern pintail. Areas of high use for northern pintail, king eiders, and long-tailed ducks are located south of Teshekpuk Lake. In winter, ptarmigan, and potentially snowy owl and gyrfalcon, could be disturbed in any of the areas. While it is likely a road would be constructed in winter, a mat system could be constructed during the summer season. Post-construction impacts on birds during the breeding season may result from: 1) vehicle and personnel traffic causing noise, visual, and/or dust disturbance along the road; 2) stream drainages or other aquatic habitats altered by the road presence; 3) greatly increased access to areas surrounding the road corridor for those engaged in waterfowl hunting or disturbance-causing activities; 4) physical and physiological contamination from fuel/lubricant spills that enter aquatic habitats; and 5) direct loss of habitat from placement of gravel. New subsistence harvest laws could increase the potential for impacts to waterfowl in areas where permanent roads allow increased access to subsistence hunters.

Overall, it is likely that bird use of habitats near a road would be altered, and the effects of road presence would vary considerably among species and by time of year (Troy 1986, Troy and Carpenter 1990, TERA 1993). Effects may be especially widespread among shorebirds. Disturbance from increased activity associated with a road would be the most important source of effects. The most likely result of disturbance from road traffic during the breeding season is for species that are intolerant of noise and human presence to seek out more distant nesting and brood-rearing habitat. Those species with highly specific breeding habitat requirements presumably would experience more difficulty locating appropriate alternate habitat, causing greater disruption of breeding season schedule, with possible effects on productivity, at least in the short term. Activity-tolerant species are likely to experience less disruption of their breeding activities. Troy (1988) and TERA (1993b) reported that all shorebirds, except red-necked phalarope, were present at lower densities near roads than away from them during the breeding season. This avoidance did not persist into the post-breeding season, when densities were highest near roads. Red-necked phalaropes were more numerous along roads, an effect probably related to dust and early snowmelt, although phalaropes may have been attracted to thermokarsted areas near roads and pads (Rodrigues 1992). Dust fallout is highest along the side of a road that is more persistently downwind, causing earlier snowmelt in spring and thus earlier availability of nesting habitats. In general, road presence may result in displacement of birds on a local scale, but probably would have relatively little effect on bird abundance in the region.

Potential impacts to aquatic habitats altered by the presence of roads could negatively impact some birds. The creation of impoundments adjacent to roads and pads could be beneficial to some species. Impacts related to habitat alteration of wetlands adjacent to roads and pads would not be expected to have population effects. In the absence of restrictive regulations, local non-oil and gas-related activity (e.g., waterfowl hunting) would be expected to have effects on bird populations, but insufficient data are available to determine the level of these impacts. However, contamination of waterfowl feeding habitat from lead shot has been implicated as a factor that may be responsible for declines in some bird populations. During winter, disturbance effects would be minor.

4.12.3.9 Mammals

Within the Northeast National Petroleum Reserve – Alaska Planning Area

If a permanent road were to connect from oil fields to Nuiqsut and the Spine Road, there would be impacts to terrestrial mammals. Potential impacts would include disturbance during construction, disruption of movements or migration, accidental mortality, and loss of habitat. Grizzly bears, wolves, wolverines, foxes, and small mammals could be disturbed during construction of the road or accidentally killed by vehicles after construction was complete. A minor amount of habitat would be lost due to road construction. Impacts to moose and muskox would be minimal given their low densities within the northern part of the Planning Area. The species most likely to be affected by construction of a permanent road would be caribou. Construction of a road from Nuiqsut to the northern portion of the Planning Area could cross the TLH caribou insect-relief area, and would disrupt movements of insect-harassed caribou between insect-relief areas and foraging areas. In addition, such a road would interfere with movements of TLH caribou between the calving grounds and other parts of their range. Construction of a road from the central or southern part of the Planning Area would be less disruptive during insect season, but would also interfere with movements of TLH caribou from wintering areas to calving grounds east of Teshekpuk Lake. Wintering TLH caribou could be temporarily disturbed by traffic. Smaller, less mobile species with small home ranges, such as squirrels, voles, and lemmings could be affected in larger numbers; however, there would be no population-level impacts on these species. Impacts to mammals would continue for the life of the road and would be dependant upon traffic levels.

Marine Mammals

A permanent road connecting potential development sites in the Planning Area to shore base and staging areas would not likely result in disturbance of beluga whales, ringed seals, or bearded seals because these animals infrequently approach nearshore habitats where noise associated with construction or traffic on such a road could be expected. Noise and visual presence of personnel during construction or use of a road, or use of an associated shore base for equipment offloading and staging, could potentially affect the behavior of spotted seals and polar bears. Seals are found in the Colville River Delta and Harrison Bay during the summer, and polar bears may occur in coastal areas in any season. Barge traffic to a shore base served by a road could potentially disturb a few individuals of these species, although it would be considered a rare event. A permanent road from the Planning Area to Nuiqsut, and from the Spine Road to Nuiqsut, would not impact any marine mammals. Disturbance effects associated with the presence of a permanent road would be likely to be negligible for marine mammal species.

4.12.3.10 Threatened and Endangered Species

A permanent road connecting potential development sites in the Planning Area to Nuiqsut would likely pass through or adjacent to important spectacled and/or Steller's eider breeding habitats. The Nuiqsut route would not be likely to affect many Steller's eiders. The Nuiqsut route could impact spectacled eiders in high use areas north of Teshekpuk Lake. In winter, these species are absent from the Planning Area. While it is likely that a road would be constructed during winter, a mat system could be constructed during the summer season. Post-construction impacts on eiders during the breeding season could result from: 1) vehicle and personnel traffic causing noise, visual, or dust disturbance along the road; 2) stream drainages or other aquatic habitats being altered; 3) greatly increased access to areas surrounding the road corridor for those engaged in waterfowl hunting or disturbance-causing activities; and 4) physical and physiological contamination from fuel/lubricant spills that enter aquatic habitats.

It is likely that after road construction, eiders may use adjacent habitats. Disturbance from increased activity associated with a road would be the most important source of effects. The most likely result of disturbance from road traffic during the breeding season would be displacement of eiders from habitats near roads, although some birds may become habituated to road disturbances. In the Prudhoe Bay area, spectacled eiders have been reported nesting near roads and oil field facilities (TERA 1996). Early green-up near roads and pads may attract eiders during the spring before other habitats become free of ice and snow.

Potential impacts to aquatic habitats altered by the presence of roads could negatively impact some eider habitat, but the creation of impoundments adjacent to roads and pads could be beneficial to eiders (Anderson et al. 1992; Warnock and Troy 1992). Impacts related to habitat alteration of wetlands adjacent to roads and pads would not be expected to have population-level effects to eiders. In the absence of restrictive regulations, local non-oil and gas-related activity (e.g., waterfowl hunting) would be expected to have effects on spectacled and Steller's eiders, but insufficient data are available to determine the level of these impacts. Contamination of waterfowl feeding habitat from lead shot, however, has been implicated as a factor that may be responsible for the spectacled eider population decline in the Y-K Delta (Flint and Grand 1997; Flint et al. 2000).

4.12.3.11 Cultural Resources

As with paleontological resources, the single greatest potential impact to cultural resources in the Planning Area is the construction of a permanent road(s), assuming that the road(s) would be built from mineral material that is locally or regionally available. Most prehistoric and historic cultural resource sites that are the result of past human activity on the North Slope lie on relatively well-drained ground. As a result, gravel deposits that have surface exposure generally support one or more cultural resource sites. There are other relatively dry locales (such as stabilized sand dunes and pingos) that occur on the landscape with much greater frequency than gravel deposits.

Many of these landscape features also support cultural resource sites. However, mineral material deposits appear to have been the most sought after and regularly used camping locales. Mineral material deposits in the region are rare, and deposits with surface exposures are rarer still, making almost any deposit worth mining for roadbed material. As a result, the potential for impacting cultural resource sites would be high if the road(s) were to be constructed of local/regional mineral material. Surveys of probable mineral material sources conducted before the start of construction, however, would be expected to identify many of the surface (and some near-surface) cultural remains.

Like paleontological resources, cultural resources are nonrenewable, and mining mineral material could either cause them to be destroyed or remove them from their natural context, thereby compromising or negating their scientific value. Even if the mineral material were not mined within the Planning Area, it would have to come from somewhere nearby, adding to cumulative impacts within the region. In addition to the potential impacts to cultural resources from the mining of the more than 3.6 million cubic yards of mineral material necessary to construct a 75-mile road within the Planning Area, the building of the road itself could cause further impacts to cultural resources.

The construction of a 75-mile road would cover the surface of the route with approximately 48,000 yd^3 of mineral material per mile, thus burying any cultural sites within the right-of-way. The proposed 18-mile route between the Colville River and Kuparuk River Unit Spine Road would require an additional 864,000 yd^3 of gravel. Cultural sites that lie on the surface could be destroyed or otherwise disturbed by this process. Near-surface cultural sites could survive the burial episode with little negative impact to their physical integrity, but would be lost as the result of being buried. However, surveys of probable road routes conducted before the start of construction would identify many of the surface (and some subsurface) cultural remains, which would help to effectively mitigate for impacts of construction. The construction of a 75-mile-long road would cover/bury a total area of roughly 320 acres; the 18-mile route an additional 75 acres. However, the road is not a block area but rather a transect running across the landscape of the Planning Area. While the total area affected would be the same, the impact of a 75-mile road would potentially be much greater than that of a block area simply because the road would traverse an extensive segment of the landscape, and would therefore have the potential to impact many more cultural resource sites than would the burial of the surface of a single block of 320 acres of tundra.

Construction of a road utilizing an interlocking mat system rather than mineral material would decrease potential impacts to cultural resources to some degree, because no mineral material deposits would be mined. However, the impacts of laying down the mat system across the landscape would be equal to, or possibly greater than, that of laying down a roadbed comprised of mineral material. Surveys of probable road routes conducted before the start of construction would be expected to identify many of the surface (and some of the near-surface) cultural remains, allowing most of the known locales of such remains to be avoided or impacts to them be otherwise mitigated. Since cultural resources are not ubiquitous in the Planning Area, though they are somewhat more predictable than paleontological deposits, and it is difficult to predict their location within the Planning Area to a reliable degree, it is extremely difficult to assess the probability of impacts to the cultural resources that would result from the construction of a permanent road. The route and location of the road(s), as well as the value or significance of the resource are needed to estimate the level and degree of potential impact. With these limitations in mind, it is assumed road construction could affect valuable cultural resources.

4.12.3.12 Subsistence

There is great concern among Iñupiat that subsistence and cultural sites could be damaged by a permanent road. In the BLM's 1979 Section 105 (c) study of National Petroleum Reserve – Alaska, the Iñupiat Community of the Arctic Slope stated in *The Iñupiat View*: "Areas identified in the TLUI (Traditional Land Use Inventory) as critical to subsistence or cultural sites should be off limits to any oil and gas exploration and development activities, including transportation systems. Activities proposed outside these sites should be evaluated on a case-by-case basis in close cooperation with local residents and representatives of the Borough and ICAS; for in order to mitigate the effects of such disruption and alien uses, in a special environment of great significance to many people, requires special knowledge that only we can provide" (USDOI BLM 1979a).

In Hall's 1983 subsistence study for the proposed Brontosaurus exploratory well, many Iñupiat were interviewed about their concerns regarding potential impacts from the project. The most important factor was the potential contamination of the local watershed and subsequent impacts on local fisheries. These observations suggest that local subsistence-based communities would have major concerns with a potential permanent road between development sites in the Planning Area. This road could compound run-off impacts over a much more widespread area, potentially affecting important resource habitats such as lakes, streams, and major rivers and threatening local subsistence fisheries.

Residents in North Slope communities have reported that building land links between local communities and other regions of the North Slope would not be desirable because: 1) they appreciated the quality of life afforded them by semi-isolation; 2) they believed that roads would have a negative impact on wildlife resources; and 3) they worried that road access would increase liquor imports into "dry" villages (ACI et al. 1984).

Walker et al. in their 1987 paper *Cumulative Impacts of Oil Fields on Northern Alaska Landscapes* found: 1) major landscape impacts from Prudhoe Bay development; 2) that indirect impacts such as thermokarst may not develop until many years after initial development; and 3) that the total area covered by direct and indirect impacts can greatly exceed the area of planned development. According to Walker et al. (1987b), "There is a need to develop methods to assess cumulative impact and to foster comprehensive regional planning to anticipate the large impacts that are likely to occur on the coastal plain in the next few years." A permanent road would represent "large" impacts and would call for a massive planning effort, accompanied by the gathering of all necessary baseline data along any potential route.

In a 1987 USFWS study that compared the actual and predicted impacts of TAPS, researchers concluded that:

> Fish and wildlife habitat losses resulting from construction and operation of the Pipeline System and Prudhoe Bay oil fields were greatly underestimated in the [USDOI's 1972 Final] EIS [on the Trans-Alaska Pipeline]. They included the direct losses of 22,000 acres from gravel fill and excavation, the even greater indirect losses of habitat quality due to the secondary impacts of construction (dust, siltation, erosion, impoundments, contaminants, etc.), and the blockage of fish and wildlife access to habitat by roads, pipelines, and causeways. Some of these indirect impacts were not predicted in the EIS, and the observed magnitude and frequency of others were greater than expected. Although some effort has been made to reduce habitat loss (through siting, consolidation of facilities, culverting, etc.) rehabilitation efforts along the Pipeline System have resulted in little restoration of habitat values. A lack of predictive capability may be expected whenever development moves into new geographical areas.

Potential permafrost loss and hydrological changes related to global climate change could compound impacts to subsistence harvests and resources from road construction and maintenance. The thawing of permafrost and associated increased maintenance costs have already become problems in Arctic and sub-Arctic areas (IPCC 2002).

A permanent road connecting potential development sites in the Planning Area to Nuiqsut would pass through important subsistence resource habitat and important subsistence-harvest areas for caribou, fish, wolves, wolverine, and birds. A road, combined with any development pipelines, would disrupt and displace caribou along its length and potentially disrupt hunting patterns by producing major alterations in hunter access patterns in both summer and winter. Any road access would represent a major artery where only trails had existed before. A road would promote the development and expansion of the oil patch, bringing with it similar issues about hunter access restrictions, hunting area reductions, trespass issues, disturbance and displacement of game, and the effectiveness of mitigation—all persistent and unresolved concerns from ongoing expansion at Prudhoe Bay, Kuparuk, and Alpine oil fields. The Dalton Highway, paralleling much of the Arctic portion of the Trans-Alaska Pipeline, has provided human access into remote regions and increased hunting and off-road vehicle impacts and accompanying impacts on caribou (Bergerud et al. 1984; NRC 2003).

A 1997 study on the proposed Eureka to Rampart road assessed impacts to subsistence resources and activities by non-local residents as a result of increased access from existing road projects. Effects identified in the study communities of Rampart, Stephens Village, Tanana, Eureka, Minto, and Manley Hot Springs included: 1) increased non-local hunter use as a result of local access using the Dalton Highway; 2) increased non-local pressure on the hunting of moose, bear, and waterfowl, fishing for salmon, pike, whitefish, and blackfish, and trapping; 3) increased noise activity from non-local hunter boat use; 4) increased minerals development; 5) state land disposals increasing home site developments and increased populations of potential subsistence users; 6) loss of habitat for subsistence resources and loss of lands used for subsistence harvests; 7) declines in moose populations; and 8) illegal use of Native lands by non-local users. As a result of this increased non-local access and hunting pressure, many local hunters curtailed their fall moose hunt and often waited until the winter season to hunt. Similar hunting, access, and habitat pressures on subsistence resources and harvest activities could be expected from potential State of Alaska or National Petroleum Reserve – Alaska road development on the North Slope.

In general, fish, birds, and caribou and other terrestrial mammals would be expected to experience greater and more continuous disturbance, mortality from vehicle collisions, and contamination effects from a road, with those nearest the road experiencing the greatest local disturbance and displacement. In the absence of restrictive regulations, local non-oil and gas related activities, including inevitable non-subsistence hunting (and the eventual pressure for increased sport hunting), would be expected to have effects on subsistence resource populations and subsistence harvest patterns, as competition between local and non-local users and subsistence and sport hunters would increase.

The combination of the 18-mile road to Nuiqsut, and a 75-mile road into the Planning Area, would produce more regional (and thus more profound) effects on the habitat and movement of subsistence resources, and on hunter access. Bridging the many productive rivers from Nuiqsut west would make these watercourses more vulnerable to siltation and fuel-spill contamination. Of primary concern would be: 1) the lack of any reliable process for assessing and monitoring changes to subsistence harvest patterns; 2) changes to hunter access; and 3) enforcement of the regulations that would already have been enacted to mitigate the profound and widespread effects such an artery would bring with it (Haynes and Pedersen 1989).

4.12.3.13 Sociocultural Systems

The presence of a road connecting portions of the Planning Area with Nuiqsut with the Kuparuk River Unit Spine Road would alter traditional Iñupiat subsistence culture. Disruptions would ripple through the sociocultural fabric, and existing institutions would be further harmed in responding to this development.

Subsistence resources could experience long-term disturbance and displacement effects that could potentially lead to reductions in resource populations, which in turn could result in increased hunter stress and a decreased sense of well-being. Even without subsistence resource population reductions, seasonal movements of caribou and other wildlife could change, causing hunters to alter traditional harvest practices by traveling to unfamiliar areas. Increased competition with outside hunters would increase existing user conflicts and could cause interethnic tensions in communities. Increased access to the community of Nuiqsut could increase the availability of drugs and alcohol, making them more affordable to those who might have avoided them because of their cost. Road access to the haul road could shift the focus of connection for Nuiqsut from Barrow to Fairbanks, as more residents would be encouraged to drive to Fairbanks for lower cost supplies and fuel. Some residents could leave the community for prolonged amounts of time, returning via the road to visit and reside in Fairbanks or other road-connected communities. Over the long term, such alterations could cause displacement of ongoing social systems and community activities by disrupting traditional practices for harvesting, sharing, and processing subsistence resources.

4.12.3.14 Environmental Justice

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB—the area potentially most affected by the presence of a road within the Planning Area. Iñupiat Natives could be affected by the road because of their reliance on subsistence foods. A permanent road could impact subsistence resources and harvest practices. Potential effects would focus on the Iñupiat community of Nuiqsut, which would be the likely focal point of a either an internal or an external road because of its location.

Subsistence resources could experience long-term disturbance and displacement effects, as well as potential population reductions, causing subsistence hunters to alter traditional harvest practices by having to travel to unfamiliar areas. If these affects to subsistence resources were to occur, long-term displacement of ongoing sociocultural systems would be expected. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources would be altered, and disproportionate effects would be expected for the Iñupiat communities.

4.12.3.15 Coastal Zone Management

The habitat, subsistence, and water-quality standards of the ACMP and the related enforceable policies of the NSB address the main areas of concern to North Slope residents. Subsistence uses of the coastal resources have been, and will continue to be of the highest priority for North Slope residents. The route of a permanent road connecting potential development sites in the northern Planning Area to Nuiqsut could pass through important habitat and important subsistence-harvest areas for caribou, fish, and birds. Activities related to road construction and the presence of a permanent road in or adjacent to coastal areas (including river crossings) would be subject to review under the ACMP. The inland coastal boundary of the NSB includes the zones of direct interaction and direct influence and extends inland approximately 25 miles. For the mid-Beaufort region, the inland coastal boundary includes certain river corridors (notably the Colville River corridor) to protect anadromous fish spawning and overwintering habitats.

If construction activities or the location of the road were likely to affect any land or water use or natural resource of the coastal zone, a review under the ACMP would be necessary. If a specific proposal were presented for review and approval, a site-specific analysis would determine whether an ACMP review were necessary and if so, which standards and enforceable policies would be applicable.

The most obvious ACMP standards that might need to be addressed are:

- Coastal Development;
- Utility Routes and Facilities;
- Sand and Gravel Extraction;
- Subsistence;
- Transportation Routes and Facilities;
- Habitats;
- Air, Land, and Water Quality; and
- Historic, Prehistoric, and Archeological Resources.

The National Petroleum Reserve – Alaska federal lands are excluded from the coastal zone. However, the CZMA requires that federal applicants proposing activities that have reasonably foreseeable effects on any coastal use or resource include, as part of their application, a certification that activities would be conducted consistent with the state's coastal management program, including the enforceable policies of the NSB CMP. If a project is located in the coastal zone and requires a federal authorization that is on the ACMP list of federal authorizations requiring review, a review would be required (15 CFR § 930.53(a)(1)). The State of Alaska may concur with or object to an applicant's certification. At the time that future site-specific plans are submitted for any activities that have reasonably foreseeable effects on any coastal use or resource of the coastal zone, the applicant would be required to submit a consistency certification to the State of Alaska.

4.12.3.16 Recreation Resources

Impacts from a permanent road within the Planning Area would have minor effects on recreation. Primitive recreation opportunities would be impacted in the immediate vicinity of the road but, as explained in the Visual Resource section, beyond a distance of ½-mile from the road, those impacts would be minimal. Sight-seeing and other road-related recreation pursuits could benefit from the road. However, if the road were to be closed to the public, as currently proposed, at least for the near term, these benefits would not be available to the public. The area from the road to a distance of approximately ½ mile away from the road would be classified as Roaded Natural (RN) under the BLM's Recreation Opportunity Spectrum (ROS) system. The rest of the Planning Area would remain classified as Semi-Primitive Motorized (SPM).

Wilderness values would be most impacted within ½ mile of the road, and, as the road would be a permanent feature, impacts would be long term. Approximately 59,892 acres (644 acres/mile x [75 + 18] miles) would be impacted, and the wilderness values of naturalness, solitude, and opportunity for a primitive and unconfined recreation experience over that area would be impacted. Additional acres would be impacted from construction of an 18-mile road between the Kuparuk River Unit and Nuiqsut, although not all acres would have wilderness values due to their proximity to existing developments.

An east-west road connecting the Planning Area to Kuparuk would result in additional impacts to both the recreational and wilderness values of the area. Raised bridges, mineral material extraction areas, and other man-made features would all contribute to the impacts on primitive recreation experiences and the naturalness of the area. If the portion of the new permanent road to the National Petroleum Reserve – Alaska would be closed to the public, it would offer no new opportunities for recreational endeavors; the road would directly affect the natural resources of the area (described in previous sections), but not public use. There would be long-term loss of the wilderness values of naturalness, solitude, and primitive and unconfined recreation near the road. If the new road were opened to the public at some future time, there would be public recreational benefits from improved access, likely at lower cost than is currently available via aircraft. Nevertheless, with no permanent public roads within the Planning Area, most of the Planning Area would remain remote and difficult to access.

A road could possibly impact outstandingly remarkable values, free-flow, and water quality on the Colville River, which was found to be eligible, though not currently "suitable," for designation as a Wild and Scenic River. The most likely effects would be approximately 3 miles upstream (south) from Nuiqsut where the road would cross the Colville River. A permanent bridge crossing at this location would slightly reduce the 97-mile length of the eligible river segment from Umiat to Nuiqsut, which is primarily considered eligible because of paleontological and wildlife resources. Such impacts would not change the determination that, although eligible, the Colville River is not currently considered suitable for designation as a Wild and Scenic River.

4.12.3.17 Visual Resources

Impacts to visual resources from a permanent road within the Planning Area would be greatest within a half-mile radius of the road. The gravel road would be raised above the surrounding terrain, and bridges would be needed to cross major rivers, both of which would contribute to the visibility of the road and the reduction of naturalness of the area. The road would impact approximately 644 acres/mi, or 59,892 acres total (644 acres/ mile x [75 + 18] miles), over the length of the road, and would result in the long-term loss of visual resources.

An east-west road connecting the Planning Area to Kuparuk would result in additional impacts to visual resources. Potential impacts would include the raised road, any bridges needed to cross water bodies, and material sites used for gravel extraction. These features would reduce the naturalness of the area and would result in the long-term loss of visual resources.

4.12.3.18 Economy

As of October 2004, the Industrial Roads Program adopted by Alaska Department of Transportation Public Facilities has envisioned development of the Colville River Road and a Colville River Bridge to facilitate and encourage resource development. According to the ADOTPF web page (http://www.dot.state.ak.us/), it is thought that this project would be likely to stimulate oil development in National Petroleum Reserve – Alaska and provide benefits to the Alaskan workers, the oil industry, the state, and the country. While the route would present security and management challenges, it would offer lower capital/operating costs to the state and would have a lower environmental impact to the region than the other alternatives (CH2M HILL 2003). The ADOTPF had planned to conduct all necessary material site exploration, hydrological surveys and environmental analyses during 2005, and construction was expected to be completed by 2009; however, the project is currently on hold while the ADOTPF reviews other potential transportation routes to the area. Economic theory suggests that savings to industry would encourage exploration and development of fields that they would not otherwise be considered. A bridge over the Colville River would allow industry to begin exploration earlier in the season than construction of an ice bridge and to bring discovery into production sooner (CH2M HILL 2003).